A PHENOMENOLOGICAL INVESTIGATION OF SELECTED TEACHERS' INFORMAL AND INCIDENTAL TECHNOLOGY-RELATED LEARNING

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by

Diana Lee Theisinger

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Approved March 2017 by

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Judi Harris, Ph.D., Committee Chair
College of William & Mary

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Leslie Grant, Ph.D.
College of William & Mary

_____
Karen Richardson, Ph.D.
Virginia Society for Technology in Education

Dedication

For my granddaddy, Richard Ervin Sanders, who would have been so proud to call me Doctor. He often joked, “Buy you books, send you to school, and all you do is draw pictures on the cover,” but he taught me the importance of listening, learning, and never giving up. For my boys, Emmett and Ellis, that you grow to be men who value the same.

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Abstract

Although many researchers have examined the ways teachers learn about technology integration along formal pathways, much less is understood about teachers' informal and incidental technology-related learning. In this study, I examined selected teachers' technology-related learning, focusing on their informal learning, which is planned learning that happens along unstructured routes, and incidental learning, which is unplanned learning that occurs by happenstance (Marsick & Watkins, 2001). Using a phenomenological research approach (Vagle, 2014), I generated data through observing, surveying, and interviewing seven teachers. I then analyzed the data, coding by discrete idea, memo-writing, reflexive journaling, and, during later stages, charting emerging results. Participants varied in years of teaching experience (4 years to more than 30 years); certifications held (special, elementary, and gifted education; secondary math; world languages; and Career and Technical Education); and grade levels taught (pre-K through 12th). Three taught in schools with active professional learning communities. All were integrating technology in classroom-based teaching and learning, at least to some extent. These teachers' experiences suggested several tentative conclusions related to the phenomenon of informal and incidental technology-related learning. Namely, it is: frequent and happens both within and across grade levels, content areas, and teaching contexts; sensitive to the pressures of time; fostered by formal organizational supports; influenced by teaching contexts, including physical spaces and professional learning cultures; and driven by teachers' learning preferences, in that both technology-avoidant and technology-savvy teachers might avoid technology-related learning that does not align with perceived learning needs and preferences. I have also included a series of

recommendations for educational leaders at the building and district level and in the field of educational technology, relative to these findings.

A PHENOMENOLOGICAL INVESTIGATION OF SELECTED TEACHERS' INFORMAL AND INCIDENTAL TECHNOLOGY-RELATED LEARNING

Chapter 1: Introduction

Teachers learn in a variety of ways, from formal to informal, structured to unstructured, and for a variety of purposes. For example, Miles is a veteran teacher, with 25 years of experience teaching high school science. Miles sometimes feels overwhelmed with the amount of information he is responsible for learning, but his many years of experience have made it easy for him to adapt to the changes each year brings. For the most part, Miles keeps to himself and uses the same tried-and-true methods that have served him well for 25 years. He stays up-to-date with changes to the science curriculum in his weekly department meetings. This year, his school division is working on a new project-based learning initiative that requires him to incorporate many types of educational technologies into his teaching. Although Miles is comfortable with basic computer software, like word processing programs and slideshow creators, he does not consider himself to be tech-savvy. The new initiative is forcing him out of his comfort zone, but he is willing to learn new strategies if they will benefit his students.

Miles does not work in a school that places much emphasis on teachers' professional learning. Professional development sessions are rare, and often concentrate on delivering information related to state testing procedures or other mandates teachers need to follow. Miles is excited about the project-based learning initiative and thinks his students will really like it, but he is worried that the brief training he and his colleagues received during pre-planning this year did not give him enough information to implement

the initiative well. He found an *Education Week* article related to project-based learning that gave him a better understanding of the model. He also reached out to a former colleague who teaches in a neighboring division; the colleague's school has been using project-based learning for several years, and after talking with her, Miles feels more comfortable about designing lessons using the new model.

However, Miles is still unsure about how to learn to use—and teach with—the many new technologies that his school division has suggested. His school employs a technology resource teacher, but she is often so busy repairing printers and laptops that she does not have time to meet with teachers for technology training. Miles's principal has suggested that teachers use videos from the Teaching Channel website to learn more about the technologies that have been recommended for project-based learning. Miles has watched a few of the recommended videos, but he would prefer to learn from a colleague; he wishes the technology resource teacher had more time to model technology integration for him or to co-teach a lesson with him so he could feel comfortable actually using new technologies in his classroom. Currently, he is learning about new technologies through trial-and-error, attempting to integrate technology into his teaching and making corrections when an idea does not support the intended learning outcomes he has set for his students. Unfortunately, Miles is finding that most of his ideas result in more challenges than successes and it often feels easier to fall back on his tried-and-true teaching approaches.

Katherine is a first-year teacher in her second semester teaching third grade. Like Miles, she often finds herself overwhelmed by the amount of information she is now responsible for: lesson plan guidelines; parent conferences; student learning profiles; a

reading curriculum that is new to her, but also new to the school. She thought her teacher preparation program had readied her for the challenges of running her own classroom, but she is finding that she still has much to learn. Unlike Miles, Katherine is fortunate to work in a school that provides many opportunities for professional development, including mentors for new teachers and active professional learning communities (PLCs).

Yet, she often finds herself wanting or needing to know more than what she learns from the school's professional development sessions and her PLC meetings. She researches lesson plan ideas on sites like Edutopia. She talks to several colleagues from her pre-service teaching days, including the mentor teacher who supervised her during student teaching, to brainstorm solutions for classroom management challenges she encounters. She also finds herself listening to her colleagues' conversations in the teachers' lounge; she has learned many valuable strategies and tips just from overhearing the ways her coworkers address problems in their classrooms.

Elaine and Cheri are co-teachers in a suburban middle school. Elaine has been teaching middle school language arts for 10 years and Cheri, her co-teacher, is a special educator with 5 years of experience. Together, they have been planning and delivering instruction for 3 years. They serve a diverse population of students, with a range of socioeconomic backgrounds, ability levels, and diagnosed learning disabilities. Elaine and Cheri enjoy teaching together. They have different professional learning preferences, but they collaborate well. This allows each teacher to benefit from the other's expertise and ideas. Elaine thinks of herself as very tech-savvy: she listens to a podcast related to reading instruction, actively maintains a Twitter network related to middle school language arts instruction, and has helped design curriculum resources for her state's

online teacher resource site. She usually takes the lead on integrating technology in the classroom, but she relies on Cheri's expertise as a special educator to adapt technology uses to meet the needs of the diverse learners in their classroom.

Cheri prefers to let Elaine take the lead when it comes to classroom innovations, but she is frequently the one who first notices a problem they need to tackle as a pair. In the fast-paced bustle of the classroom, Cheri does not always have time to reflect; a lot of her thinking happens outside of school. For example, Cheri often reflects on classroom challenges during her weekly yoga sessions. Last week during yoga, she realized one student who had been persistently disengaged throughout the semester had actually been very engaged during Elaine's mini-lesson on poetry. He seemed to really "tune in" when he was offered the chance to record and share his own poetry using SoundCloud. Cheri and Elaine talked about this the next day and brainstormed several ideas to further engage this student. Although Cheri relied on Elaine's expertise related to using SoundCloud, they both worked together to generate more ideas for this student to create and share his writing. Cheri also listens to NPR each morning on her drive to school. It is not unusual for her to arrive at school excited to share with Elaine an idea for enriching the day's lesson with a piece of news trivia she knows will make learning relevant to their students. Elaine relies on Cheri for these last-minute lesson enhancements and the students have come to expect their language arts content to connect to current events in some way.

Jeff is an AP History teacher and the basketball coach at a small rural high school. He has 7 years of teaching experience and serves on his school's leadership team. In fact, because his is such a small school, he serves in many roles—teacher, coach, teacher-leader, and, occasionally, professional development instructor. For the last 3 years, his

principal has asked Jeff to coordinate history instruction for their district-wide professional development days. These are teacher work days aimed at vertical articulation, where all teachers in the same subject area, across the grade levels, meet to talk about the ways their curriculum aligns and overlaps. Again, because Jeff works in a small school district, with only one elementary, middle, and high school, these district-wide sessions involve just a few teachers. Jeff enjoys the challenge of deciding which materials will be most helpful to the teachers across the grade levels and of continuing to foster collegiality among the members of what he considers to be "his" department. He also enjoys being seen as a teacher-leader within his district. He takes his principal's trust very seriously and puts a lot of energy into planning effective instruction for the district-wide sessions.

Last year, Jeff attended a summer institute for history teachers offered by the state college. Even though it meant a 3-hour drive and a week away from his family, Jeff felt it was important for him to continue learning so he could offer new ideas, not only in his classroom, but also to the other teachers in his school district. One area he was particularly interested in learning more about was virtual field trips. His school district is too rural (and too underfunded) to take many history-related field trips, but Jeff knows that many museums now offer rich online curricula related to his content area. The summer institute included an entire day dedicated to planning and integrating virtual field trips into the history curriculum.

Jeff came away from the summer institute with a notebook full of new ideas, renewed enthusiasm for his roles as history teacher and professional development instructor, and access to an extended network of colleagues from across the state. He has

stayed in touch with several of these long-distance colleagues, connecting through the wiki they set up during the summer institute. They share ideas and questions, as well as sample lesson plans. Jeff has come to rely on this community of colleagues when making his professional development plans; he posts an outline of his plans on the wiki and has feedback from several other teachers within a few hours. This makes him feel more confident in the quality of the instruction he delivers to the rest of the teachers in his district and often takes him in new directions he would not have thought of on his own. He has also planned his first virtual field trip, using tools he learned about during the summer institute, as well as ideas generated during the last district-wide professional development sessions. Several other teachers in the district are also planning virtual field trips thanks to Jeff's guidance.

Teacher Learning Along Many Pathways

The vignettes in the previous section are meant to illustrate the many ways teachers learn to integrate technology in their classrooms. Miles, Katherine, Elaine, Cheri, and Jeff represent typical teachers, in that they are engaged in many forms of learning. In fact, many teachers are lifelong learners, either through disposition or due to recertification requirements (Richter, Kunter, Klusmann, Lüdtke, & Baumert, 2011; Straka, 2004; Tarc, 2007). Plentiful research on the subject shows that teachers learn for many different reasons, in many different ways, along many different pathways (e.g., Bolt, 2012; Lohman, 2006; Opfer & Pedder, 2011; Putnam & Borko, 2000; Richter et al., 2011). For example, when Katherine works through a lesson plan with her PLC, she is learning. She also learns through searching Edutopia and listening in on other teachers' conversations. Miles learns from his readings in *Education Week* and through his own

classroom trial-and-error experiences with technology. Elaine and Cheri learn from one another, through collaboration. Each also learns along the individual pathways she pursues: Elaine learns from podcasts and Twitter; Cheri learns from reflecting on her teaching and listening to NPR. Jeff learned from the summer institute he attended, and then extended his learning through professional development sessions with other history teachers in his school district and sharing in the online community he developed with his long-distance colleagues.

Miles, Katherine, Elaine, Cheri, and Jeff also represent typical teachers in that they find some of their learning needs unmet by the supports their schools offer. Even after participating in formal professional development sessions and PLC or department meetings, teachers often continue to build on their professional learning through less formal routes—reading blogs and articles, talking with colleagues or mentors, overhearing useful ideas in public spaces, and learning through experimentation (W. M. Jones & Dexter, 2014; Lohman, 2003). Several of these latter types of learning are examples of informal learning, which Marsick and Watkins (2001) defined as "intentional but not highly structured" (p. 25) learning that often takes place in order to solve a problem. Others, like overhearing ideas from colleagues or the radio, are examples of incidental learning, which Marsick and Watkins (2001) defined as learning that happens along the way to answering a different question or solving an unrelated problem.

In particular, many teachers may find that formal professional development leaves their technology integration learning needs unmet (Berry, 2015; Moen, 2015). This might be due to a variety of factors: a lack of adequate time for hands-on practice (Matteson,

Zientek, & Özel, 2013; J. G. Wells, 2007), the newness of technology and resultant lack of formal learning resources (Kessler, 2007), or simply a preference for independent exploration of new educational technologies (Smaller, 2005; Webster-Wright, 2009). For these teachers, informal learning may fill the gaps left by formal modes of professional learning. They might need "just in time" support for their learning (W. M. Jones & Dexter, 2014). They might prefer the individualized nature of informal learning (Carliner, 2012). They might want to learn in a way that is low-cost or free (Kendall, 2004). All of these—and more, to be discussed in Chapter 2—are advantages of informal and incidental learning.

Study Overview

The purpose of this study was to illuminate teachers' informal and incidental learning related to technology integration. Using a phenomenological approach (Vagle, 2014), I explored the ways seven teachers—teachers who had many things in common with the representative teachers in the vignettes at the beginning of this chapter—learned informally and incidentally about technology integration. Phenomenological research is used to shed light on a particular phenomenon by gathering rich, diverse data related to participants' lived experiences (Vagle, 2014). Through analysis of interviews, surveys, and observations, I built a deeper understanding of the complex and largely unexplored phenomenon of these teachers' informal and incidental technology-related learning.

In Chapter 2, I present relevant research related to teacher learning, including teacher learning through formal professional development, within communities of practice and PLCs, through personal/professional learning networks (PLNs), and, finally, their informal and incidental learning. I then examine the research related to teachers'

learning about technology integration. Throughout this review of the literature, I focus on the important role of context in teacher learning.

In Chapter 3, I delve deeper into the theoretical framework and phenomenological research approach that guided my study. I provide further discussion related to my choice of participants and the data generation and analysis methods I used, including the quality criteria that supported the credibility of my findings.

In Chapter 4, I introduce readers to the teachers who participated in my study and the school district, Dogwood Public Schools, where they work. Like the representative teachers presented in the vignettes at the beginning of Chapter 1, the teachers in my study—Celeste, Brianna, James, Susan, Karla, Ashley, and Melissa—were all engaged in technology-related learning, at least to some extent. I share more information about these teachers, their learning needs and preferences, their classroom contexts, and the educational technologies they are learning to integrate.

In Chapter 5, I examine the many ways the teachers in my study learned, informally and incidentally, about integrating technology in the classroom. I look across these teachers' individual experiences as learners to draw tentative conclusions about the phenomenon of teachers' informal and incidental technology-related learning.

Finally, in Chapter 6, I synthesize my tentative findings and make recommendations for educational leaders at the school and district level, as well as those in positions of educational technology leadership, relative to these findings. These recommendations are situated within relevant extant literature.

Chapter 2: Literature Review

The field of teacher learning is broad, multi-faceted, and the subject of much research. Definitions, explanations, and recommendations for best practices abound. Yet some researchers have questioned the assumption that teacher learning can be reduced to a single formula; instead, they argue, any understanding of teacher learning developed will be inherently incomplete (Opfer & Pedder, 2011). There are simply too many variables, too many moving parts, for any one set of criteria to describe teacher learning entirely (Opfer & Pedder, 2011). Those descriptions that can be offered will all be limited by context, another richly diverse and complex field of research (e.g., E. Wilson & Demetriou, 2007). However, certain general assumptions and understandings about the nature of teacher learning may be possible.

Teacher learning, a type of professional learning, is a process that typically begins with teachers' formal education and certification programs, and continues throughout their professional careers. Professional learning has been defined as any type of learning professionals report engaging in (Webster-Wright, 2009). It will be important in later sections of this chapter to differentiate between the commonly used term *professional development*—which refers to the activities intended to cause learning to happen—and the broader concept of *professional learning*. Professional learning is a continuous process not associated with any one distinct event or activity (Webster-Wright, 2009).

For the purposes of this research, I focused on studies of teachers who had completed their formal, university-based education, and who were already in the field, rather than pre-service teachers. The research related to pre-service teacher learning is broad and plentiful, but it is beyond the scope of my focus. For my purposes teacher learning can be viewed on a continuum from formal to informal and incidental, with many intermediate levels in between. Formal learning refers to structured, planned learning activities, organized for and delivered to teachers by an outside agent (Feiman-Nemser, 2001), such as members of a school's administrative team or the professor teaching a university course. Teachers might be mandated to attend these activities, either through continuing education requirements for their professional licensure or as a condition of employment (Feiman-Nemser, 2001). Informal learning, on the other hand, refers to learning that is unstructured and is generally learner-directed (Marsick & Watkins, 2001); that is, the teacher seeks knowledge independently of outside mandates. I will develop this definition more fully in subsequent sections of this chapter.

Tracing the path of the continuum of teacher learning, I begin with an overview of research on formal teacher learning, in the form of professional development. I continue with a discussion of the research on progressively less formal types of teacher learning, like communities of practice, professional learning communities, and personal learning networks. Next, I synthesize the research about teachers' informal learning, including examples of the many ways teachers learn informally and incidentally. Because my research on teacher learning ultimately focused on how selected teachers learned informally and incidentally about technology integration, I consider these many types of teacher learning specifically as they relate to teachers incorporating technology in the

classroom. Finally, throughout this research synthesis, I remind readers of the important role of context in teachers' learning about technology integration.

Professional Development

Teachers' professional development usually happens over the course of their careers. Driven in part by the standards movement and the increasing push for professionalization of teaching, recent years have seen a heightened focus on teachers' professional development (W. M. Jones & Dexter, 2014; Opfer & Pedder, 2011; Richter et al., 2011; S. M. Wilson & Berne, 1999). What is meant by the term professional development can vary widely, but for the purposes of this discussion, I have synthesized the definitions of several often-cited researchers in the field. I describe professional development as any structured activity organized by an entity other than the teacher-as-learner—such as a school principal, school district, or outside consultant—with a pre-determined curricular focus (e.g., Guskey, 1991; Opfer & Pedder, 2011; Webster-Wright, 2009). Teachers' participation in professional development activities might be compulsory or voluntary; whole group, small group, or individual; and related to a wide variety of topics. Professional development might take the form of workshops, online classes, continuing education courses offered by universities, or any other type of formally organized learning activity designed with the intent of encouraging teacher learning.

Many researchers have conducted studies and reviews of the literature to provide recommendations for what might be considered "best practices" in conducting effective professional development (e.g., Garet, Porter, Desimone, Birman, & Yoon, 2001; Guskey, 1991; Timperley, 2008). Guskey (1991), who has researched and written

prolifically on the topic, synthesized the research related to effective professional development into the following list of recommended characteristics. Effective professional development:

- has an individual focus vs. a policy or program focus.
- gradually builds toward larger goals.
- incorporates stakeholders from all levels of the organization.
- uses specific, individual feedback for participants.
- is a process, rather than an event and includes ongoing support.

Similarly, Timperley (2008) synthesized the results of 97 international studies of professional development that led to positive results for "valued student outcomes" (p. 6). Although more comprehensive, her list of best practices shares many commonalities with Guskey's (1991) list. She concluded that effective professional development:

- focuses on desired student outcomes vs. teachers' skill mastery.
- uses research-based, context-specific strategies.
- integrates content expertise, pedagogical skills, and knowledge of assessment to check for student understanding.
- provides many chances for teachers to learn and practice new skills.
- uses a varied teaching approach and is responsive to teachers' prior knowledge.
- provides chances for teachers' collaboration with colleagues.
- relies on external expertise to change ineffective practices.
- actively involves school leaders.
- provides structures to sustain momentum.

Both Guskey (1991) and Timperley (2008) have stressed the need for a focus on teachers as individual learners, the inclusion of school leaders in professional development, and the need to make professional development an ongoing process, rather than a one-time event.

In formal settings, such as the schools where they work, teachers often volunteer for learning opportunities for the purpose of adding new strategies or techniques to their repertoire; rarely is their focus on fundamentally changing their knowledge of content or pedagogy (S. M. Wilson & Berne, 1999). In their analysis of six separate studies examining high-quality examples of professional development, S. M. Wilson and Berne (1999) concluded that each example of successful professional development was characterized by three common elements: teachers chose to continue learning after the formal professional development had ended; teacher learning was activated, rather than delivered (p. 194); and a community of trust was developed that included teachers providing one another with critical feedback. The researchers offered the caveat, though, that even in these exemplary cases of professional development, teacher learning could not be guaranteed—only attendance could be assured.

Webster-Wright (2009) has argued that much of the research into professional development is flawed by incorrect assumptions researchers make about the construct of professional learning. In her critique of over 200 mostly empirical studies (81 of which were directly related to the field of teaching), she found much of the extant research on professional development to be focused on specific activities or learner characteristics rather than the extent of realized professional learning. She concluded that there is a misalignment between what is known in the literature about how professionals learn and

what is practiced in many professional development activities. Part of the challenge of understanding teachers' professional learning is its sporadic nature. In their review of literature related to why teacher learning does or does not occur as a result of professional development, Opfer and Pedder (2011) concluded that what teachers learn and how their behaviors and beliefs change as a result of learning might not be linear or distinct processes. In other words, teachers might continue to learn in a variety of ways from a variety of sources throughout their careers, including, but not limited to, professional development activities. This suggests that to ignore any pathway to learning in favor of another—such as giving preference to formal professional development opportunities at the expense of less formal learning opportunities—might be to deny rich learning opportunities and the resultant potential for improved instruction.

An important criticism of formal learning is that it may be approached in a standardized one-size-fits-all manner, with the assumption that workplace problems are simple and straightforward and can therefore be addressed by a single format of training (Eraut, 2004), such as an afternoon workshop presented to the whole staff. Problems are complex and learners are diverse; focusing exclusively on formal learning approaches might lead organizations to overlook the need for more individualized and informal approaches to learning. Further, the excessive cost of implementing the kinds of large-scale, long-term, high-quality professional development aligned with research-based best practices might be prohibitive for many schools (Garet et al., 2001). In recent years, worries over cost, combined with shrinking school budgets, have led many school districts to explore alternative paths to teacher learning (Garet et al., 2001; Thessin,

2007), including communities of practice, PLCs, PLNs, and teachers' informal learning (Marsick, Shiotani, & Gephart, 2014).

Communities of Practice

In theory, communities of practice are highly informal learning arenas; but in practice, the term is often applied to entities that are a blend of formal and informal learning practices or, in some cases, entirely formal, structured groups of learners. Wenger (2006), the researcher who coined the term, defined communities of practice as "groups of people who share a concern or passion for something they do and learn how to do it better as they interact regularly" (para. 4). Wenger suggested communities of practice adhere to three characteristics:

- "a shared domain of interest" (para. 6)
- "members who engage in joint activities and discussions, help each other, and share information [in order] to build relationships that enable them to learn from each other" (para. 7)
- a shared practice, trade, or craft combined with a shared dedication to improving (para. 8)

Wenger's explanation of communities of practice emphasized that they are often not formally labeled as such; an organization—or a grade-level team—might be functioning as a community of practice without realizing or acknowledging it in any official capacity. Herein lies the challenge of studying communities of practice: where they exist, according to Wenger's definition, their members might not realize they do. Printy (2008) has referred to these unknown communities of practice as naturally occurring,

differentiating them from communities of practice purposefully designed as a tool for teachers' professional development.

Taken as a whole, there is a very large body of research related to communities of practice. Yet, there does not appear to be a clear consensus among researchers about what constitutes a community of practice with respect to teacher learning. Widely varied definitions coupled with different interpretations of Wenger's (2006) definition make it difficult to see how this construct fits into the broader picture of teacher learning. In fact, much of the research in this field seems to force the label "community of practice" onto any group of teacher learners, regardless of the circumstances that formed the group or the nature of the group's interactions. For example, one group of researchers studying online communities of practice cited several definitions (including Wenger's) to support the idea that communities of practice are tools for teachers' professional development (Murugaiah, Azman, Thang, & Krish, 2012). In their Malaysian case study, the researchers followed the blogging activities of a cohort of five English teachers. These teachers were required to work together (i.e., they had been assigned by supervisors to join the cohort), required to post in a shared blog, and required to respond to one another's posts. Further, when three of the members showed an initial reluctance to participate, "timely intervention of the moderators" (Murugaiah et al., 2012, p. 167) prompted them to increase their online activity. It was clear that nothing about this community of practice was naturally occurring (e.g., Printy, 2008). Yet, the researchers did not acknowledge this limitation; in fact, they framed their conclusions around whether communities of practice are effective arenas for teacher learning. This study illustrates the kind of misinterpretation of communities of practice that is common in the

literature; the authors seemed to ignore the apparent contradiction between the teachers' forced togetherness and mandated participation and the ideas of shared practice and mutual dedication that are central to Wenger's (2006) definition.

Another example comes from a case study of eight teacher-learners using Twitter to facilitate their informal learning (Britt & Paulus, 2016). Despite concluding that activities in a weekly online chat were (a) strongly led by and dependent on the intervention of the chat's moderators, (b) regularly included only 17 members, and (c) did not extend to interactions beyond Twitter, the authors still characterized the entirety of the group's more than 2,300 participants as a community of practice. It is hard to see how these members, even if they chose to come together based on an initial shared interest in improving their practice as educators, could be said to "engage in joint activities and discussions, help each other, and share information [in order] to build relationships that enable them to learn from each other" (Wenger, 2006, para. 7). Likewise, when Stein and Coburn (2008) studied four schools from two urban school divisions, they professed to rely exclusively on Wenger's definition of communities of practice. Yet, the researchers (a) designed their study around the assumption that all of the teachers in each of the schools they studied were automatically members of a community of practice; (b) deemed certain conversations among teacher learners as misaligned with district initiatives, and therefore not relevant to the teachers' learning; and (c) characterized the district-initiated teacher learning initiative as a community of practice. The researchers found conflict and problems within the groups of teacher learners at each school and recommended that district leaders look instead for existing communities of learners within their schools and urge those communities toward deeper

learning. However, the researchers did not acknowledge the possibility that the groups of teacher learners they were studying might not actually have been communities of practice.

Some researchers have been more reflective in their attempts to study what happens in communities of practice that are created artificially, rather than forming naturally. For example, Mak and Pun (2015) studied 18 English teachers in Hong Kong during and after their participation in an intensive summer institute. They noted that the institute's coordinators formed the group and participants did not know each other prior to arriving for the first day of training. The coordinator dictated group norms during this first day of training and initial participation was lively. However, after the institute concluded, there was no long-term engagement or interaction among group members; during the group's final meeting 8 months later, only 4 of the 18 initial participants attended. The researchers concluded, "the teacher community cultivated seems precarious when its members returned to their work" (Mak & Pun, 2015, p. 19). In other words, communities of practice that are not naturally occurring might not function effectively to support professional learning. Similarly, Bilodeau and Carson (2015) studied a group of 12 university librarians. After conducting semi-structured interviews with the librarians about their learning throughout their careers, the researchers found many of the same characteristics that are true of teachers' learning are true of librarians' learning as well. For example, participants in the study reported that their formal coursework was not their most meaningful learning; instead, their most meaningful learning came from observing or working alongside colleagues and learning on the job. The researchers noted that the librarians had transitioned from a sort of forced community of practice, during their time

as graduate students, to a more genuine, professional community of practice once they started their careers. Because the librarians self-selected professional mentors and colleagues later in their careers, this latter community encouraged the librarians' active participation in a way that the de facto graduate student community of practice had not. Ultimately, the researchers concluded that communities of practice that are "implemented and planned purposively" to encourage professional learning are "one step removed from an authentic community of practice" (Bilodeau & Carson, 2015, p. 30). This mirrors Printy's (2008) distinction between communities of practice that are naturally occurring and those that are purposefully designed.

It is important to note that not all studies using the term community of practice misapply or misinterpret Wenger's (2006) framework. Wesely (2013) conducted a netnography of an online group created by World Language teachers using Twitter. She became a participant observer, joining in the group's online conversations over the course of many months. Only after extensive participation with and observation of the group did she realize they might be considered a community of practice. She then recruited nine of the group's most active participants for individual interviews about their learning as members of the group. After an in-depth, recursive analysis of her field notes and interview transcripts, Wesely concluded that, although individual participants viewed their participation in the group more as part of their own personal learning networks, the group as a whole was functioning as a community of practice. In fact, of the nine participants Wesely interviewed, five had worked on curricular initiatives with fellow members of the group outside of Twitter. Wesely (2013) concluded:

> Promoting participation in online professional development communities like the [community of practice] outlined in this study must focus not on basic physical/digital access issues but rather on the social psychological factors that might act as barriers to teachers' participation. One-on-one mentoring, multiple exposures to the community, low-stakes introductory sessions (e.g., one-time participation in a hashtag chat with a temporary Twitter account), and combining [communities of practice] with established forms of professional development delivery might all serve to help teachers overcome their reservations…it is advisable that collaborative Web technologies not be presented as a time-saver or a way to reach a specific goal, but rather as a way for teachers to find community and collaborators. (p. 315)

Here, Wesely alludes to a theme that emerges across the literature of teacher learning (and one I will explore more deeply in subsequent sections of this chapter): there might not be any single most effective pathway to teacher learning. Rather, a blend of different approaches might be necessary to satisfy all of teachers' learning needs. Unfortunately, Wesely's (2013) study is the exception to an otherwise inconsistent field of research related to communities of practice. Further complicating the research in this field is the varying application of the term community of practice to both naturally occurring communities and those that are artificially imposed. This makes it difficult to form generalizations or synthesis regarding communities of practice as an arena for teacher learning. However, this background knowledge is valuable to forming a complete understanding of the many ways teachers learn, especially since much of the research related to PLCs and PLNs references earlier work on communities of practice.

Professional Learning Communities (PLCs)

One model of teacher learning that has emerged from both the business sector and the research related to communities of practice is the PLC (Vescio, Ross, & Adams, 2008). Although descriptions of PLCs vary, Stoll and colleagues (Stoll, Bolam, McMahon, Wallace, & Thomas, 2006) conducted an extensive review of the international literature and concluded a PLC is any group of professionals working to improve their practice for a common goal. There may be subtle differences in how PLCs are implemented in schools, but common characteristics include a focus on student learning (as opposed to the practice of teaching); ongoing, reflective collaboration among teachers; and a commitment to using data in meaningful ways to ensure student achievement (DuFour, 2004; Stoll et al., 2006). PLCs may include formal professional development opportunities, along the lines of those described in the "Professional Development" section of this chapter, but there are important differences distinguishing PLCs from other professional development models (Stoll et al., 2006). In educational settings, the purpose of PLCs is for small groups of teachers to learn together and work toward a common goal of meeting students' learning needs (Vescio et al., 2008). Although some schools rely on PLCs to emerge organically, there is substantial evidence pointing to the need for these groups to be developed and implemented through the efforts of school leaders (Thessin, 2007; C. M. Wells & Feun, 2013). Many PLCs are, at least in part, formally structured and should be considered closer to the formal end of the teacher learning continuum than the informal end.

DuFour (2004) has cautioned against the overuse—and misuse—of the term PLC when it is applied to extant groupings of teachers, such as grade-level teams, who are not

truly functioning as collaborative communities focused on student learning. Grade-level teams may, in fact, function as PLCs, but more often meet for purposes separate from improving student learning, like lesson planning, discussing student discipline issues, or learning about new district policies. Effective PLCs meet solely for the purpose of examining and improving student learning. Illustrating this point, C. M. Wells and Feun (2013) studied eight middle schools from two districts implementing PLCs. They found, based on teachers' and administrators' perceptions, one of the districts had substantially more success with PLCs than the other. The key difference in the two districts was that the less successful district used PLCs only as a means for teachers to meet and share materials; the more successful district used PLCs to analyze student learning critically and collaboratively.

However, there is evidence that when PLCs are implemented with a singular, data-driven focus on student outcomes, learning problems can be effectively addressed and student achievement can improve (Vescio et al., 2008; C. M. Wells & Feun, 2013). In a review of literature related to professional development and PLCs, Little (2006) concluded professional development presented in the context of an established PLC may have reciprocal effects on both teacher learning and school culture. In other words, when teachers learn within a PLC, both the school's culture of collaboration and the teachers' learning may improve. Similarly, Vescio and colleagues (2008) analyzed 11 empirical studies of PLCs in schools across the US and UK and found in each case, the professional culture of the school shifted once PLCs were implemented. Teachers from the studies included in the analysis reported higher levels of collaboration, a stronger focus on student learning across the school, and an increased interest in lifelong learning after

PLCs were implemented. This research could suggest PLCs are one method by which schools could transform their culture into one more conducive to lifelong learning.

In a 2-year study of a mid-sized urban school district implementing PLCs, Thessin (2007) identified eight characteristics associated with PLC success. Successful PLCs:

- are ongoing, rather than episodic, in nature.
- acknowledge the unique role of context.
- align with other district reforms.
- are collaborative.
- depend on a common vision/purpose related to student learning.
- use data.
- rely on shared leadership.
- show "the presence of certain structural and cultural conditions" (p. 17).

Thessin elaborated on the conditions mentioned in the final bullet point as a need for districts to ensure school leaders and school cultures are ready for the hard work of implementing PLCs. The 28 teachers interviewed for the study agreed that professional development explicitly related to how to develop and sustain successful PLCs was beneficial. Further, Thessin (2007) recommended districts take a differentiated approach to implementing PLCs that is responsive to each school's level of cultural readiness for the shift to a more collaborative professional learning model. Schools struggling with issues of teacher morale, high turnover rates, or frequent changes in school leadership might not meet the cultural readiness conditions Thessin describes.

Thessin's (2007) findings mirror those of other researchers (e.g., Owen, 2014; Stewart, 2014; Stoll et al., 2006; C. M. Wells & Feun, 2013). In their study of two districts, one with successful PLCs and the other with struggling PLCs, C. M. Wells and Feun (2013) concluded that successful PLCs often require major, school-wide changes. Teachers from the district where PLCs were working well were much less resistant and resentful of the changes required of them, a fact they credited to the explicit professional development related to participating in PLCs their school district provided. The researchers concluded schools must be ready to invest considerable time in developing and sustaining effective PLCs. Owen (2014) conducted a case study of three Australian schools implementing PLCs and, again, found successful implementation required time. She also identified a need for school leaders to provide teachers with clear expectations for what and how their PLCs should function, which is similar to other researchers' findings of the need for effective school leadership in successful PLCs (Thessin, 2007; C. M. Wells & Feun, 2013).

One challenge in implementing PLCs with fidelity is the tremendous amount of work required to build and sustain them effectively (Owen, 2014; Stoll et al., 2006; C. M. Wells & Feun, 2013). In schools facing challenges with culture or morale, or where other needs are more urgent or pressing than teacher learning, PLCs may not receive the careful attention needed to be successful. Similarly, in schools where there is not a consistent leadership structure, the ongoing effort required to sustain PLCs may be infeasible (Stoll et al., 2006). When C. M. Jones and Thessin (2015) reviewed 125 studies related to PLCs, they concluded that school leaders and the teachers involved in the groups have to be responsive to natural, cyclical changes that take place during the

developing, implementing, and sustaining phases of PLCs. Successful PLCs required continual work and reevaluation. Another challenge is related to school structure: some researchers have suggested PLCs work best in smaller schools that can allow teachers to plan together regularly (Darling-Hammond & Richardson, 2009). These conditions might not be feasible in all schools.

Again, because PLCs are, at least to some extent, formally structured entities, they fall closer to the formal end of the continuum than other, less structured, types of teacher learning. School administrators, like principals or division officials, are responsible for the groupings that constitute most PLCs. To understand less formal and structured types of teacher learning, I next examine the literature related to teacher-directed learning pathways, such as PLNs and teachers' informal and incidental learning.

Personal/Professional Learning Networks (PLNs)

Alternatively described as personal learning networks (Bauer, 2010; Sie et al., 2013) and professional learning networks (Deissler, Ding, Neumann, & Kopcha, 2015; Trust, 2012), PLNs are loosely defined as a collection of resources—human, physical, and digital—related to a particular area of interest or expertise, that a learner can access when additional information is needed (Bauer, 2010). PLNs can take many forms: thematic Facebook groups, Twitter accounts dedicated to professional learning, a curated set of blog subscriptions delivered via RSS feed, or a subscription to a particular professional journal or YouTube channel. In practice, a PLN is often a collection of many of these digital and print resources combined with access to a few mentors or experts who are available to consult as needed. Although PLNs are as diverse as their users in content

and structure, they generally adhere to a set of characteristics proposed by Nussbaum-Beach (2012); PLNs are:

- user-directed.
- reciprocal, in that the user both contributes to and learns from the PLN.
- often reliant on online resources.
- multi-dimensional, in that multiple streams or channels of information are required to establish a single PLN.
- strategic, in that they require users to regularly manage subscribing, following, or contributing to the network.

There is relatively little recent empirical research about PLNs; however, writers of most articles and studies have noted a few common characteristics. First, participation in a PLN is not limited by a person's physical location or time zone because communication within the PLN is often asynchronous or on demand (Bauer, 2010; Sie et al., 2013; Trust, 2012). Because the content of a PLN is almost entirely determined by the teacher's learning needs and preferences, this is a much less formal mode of teacher learning than either professional development, forced communities of practice, or PLCs. However, some level of formality remains since PLNs are structured and, in the case of resources like Twitter, Facebook, or RSS feeds, PLN users must rely on external sources for updated information about a given topic. Further, teachers must regularly curate and maintain a PLN for it to remain useful and relevant (Nussbaum-Beach, 2012), even in the absence of any particular need for learning, which makes PLNs slightly different from purely informal, unstructured learning. Some researchers have characterized PLNs as supports for informal learning (Trust, 2012), but this characterization might only apply in

instances where the PLN was developed naturally and is maintained by the learner in an active, intentional way (Sie et al., 2013). A PLN that is established by a teacher, and then languishes, forgotten, in the background, could hardly be seen as a support for any form of teacher learning. In their study using Twitter, Sie and colleagues (2013) found reciprocity was essential to the success of the PLN they studied: in order to stay engaged in the PLN, participants expected to get as much information from the network as they provided to the network.

Although not explicitly a study of PLNs, the findings from an Italian study of "professional Facebooking" (Ranieri, Manca, & Fini, 2012, p. 756) might also have bearing on this topic. Researchers surveyed almost 600 users—some, teachers; others, health professionals or parents of school-age children—in two Facebook groups related to teaching and learning to find out how their interactions on Facebook translated to their real or professional lives. One group was classified as a general interest group, with discussion topics centering on teaching and learning. The other group was thematic, with discussion focusing on the topic of dyslexia. The researchers were surprised to find members of the general interest group, with weaker professional ties, reported higher real and professional learning gains from their group participation. Ranieri and colleagues (2012) posited that, in virtual environments, members with weaker ties to a topic were more likely to encounter new—and thus practical, applicable—information when compared to members of the thematic group who likely had stronger ties to the topic outside of the online group. In other words, virtual groups on topics generally related to a profession (such as those that are part of a person's online PLN) may offer fresh perspectives and be useful for professional learning. However, in practice, the need for

PLNs to be multi-dimensional and strategically maintained (Nussbaum-Beach, 2012) may be a barrier to their natural occurrence. It is possible that for some teachers, a productive PLN might require more effort than it is worth.

Just like externally structured communities of practice and PLCs, PLNs that are mandated by a supervisor or that do not emerge organically might have more in common with formal modes of learning than informal. For example, when Oliver (2016) required students in his online course—14 in-service teachers working toward a Master's degree—to participate in a PLN using Twitter, he found that many of their interactions were forced. Users posed questions that went unanswered; most of the discussions focused on other class assignments, rather than problems of practice; and only half of the students continued to use Twitter after the class had ended. The students reported that participating took a lot of time and needed to be a habit in order to be useful (Oliver, 2016). When a PLN is required and the motivation for participating in it is entirely extrinsic, it might be subject to the same barriers and constraints as other formal modes of teacher learning. Also, recall from the earlier section on professional development that an important criticism of many professional development models is their one-size-fits-all approach (Eraut, 2004). A PLN such as the one in Oliver's (2016) study is not appreciably different from this approach.

Finally, some researchers have suggested that developing a useful PLN requires a person to have a strong concept of personal and professional identity (Oliveira & Morgado, 2015). This might present a barrier for novice teachers, who are still working to build an identity in the early stages of their careers (McCormack, Gore, & Thomas, 2006). In short, just like formal professional development, communities of practice, and

PLCs, PLNs alone are unlikely to meet all of a teacher's professional learning needs. Instead, researchers have increasingly recognized the importance of professionals' informal and incidental learning to fill in the gaps left by other modes of teacher learning.

Informal and Incidental Learning

Livingstone (2007) defined informal learning as "any activity involving the pursuit of understanding, knowledge, or skill that occurs without the presence of externally imposed curricular criteria" (p. 206). Marsick and Watkins (2001), who have published extensively on the topic, defined informal learning as "intentional but not highly structured" (p. 25) learning that occurs in response to a problem or need for more information. In contrast to the four previous examples of teacher learning discussed (professional development, communities of practice, PLCs, and PLNs), informal teacher learning has no prescribed structure, may vary in form and format from day to day or problem to problem, and is completely learner-directed.

Eraut (2004) has outlined a well researched typology of informal learning that, although it includes teacher learning, extends beyond the field of education to all types of informal workplace learning. This typology includes three levels of informal workplace learning: deliberative, where the learner methodically plans learning opportunities; reactive, where the learner intentionally seeks a solution to a problem or question in the moment; and implicit, where the learner is not conscious learning has taken place. Eraut's (2004) typology is a useful frame of reference since other researchers have applied it to teachers' informal learning (e.g., Hoekstra, Beijaard, Brekelmans, & Korthagen, 2007). Both deliberative and reactive learning could be characterized as modes of informal

learning, since they are learner-directed and not reliant on an outside entity for planning or delivery.

Related to Eraut's (2004) construct of *implicit learning* as unconscious learning, the construct of *incidental learning* might permit additional understanding of more subtle types of teacher learning. Incidental learning has often been conflated with informal learning. Although Marsick and Watkins (2001) have acknowledged incidental learning is ongoing and happens alongside informal learning, they have also defined incidental learning in its own right as learning that happens along the way to answering a different question or solving an unrelated problem. In other words, incidental learning happens by accident or coincidence, when learners stumble across a piece of information they were not consciously looking for. For example, if a teacher happens to hear a useful news story related to a topic on this week's lesson plan, like Cheri in Chapter 1, he or she has engaged in incidental learning. In the next section, I address teachers' informal and incidental learning in greater depth.

Teachers' Informal and Incidental Learning

Research into teachers' informal and incidental learning may have risen in popularity as a result of "lifelong learning" movements in teacher education—the idea that teachers should continue developing their repertoire of skills throughout their careers (Hoekstra, Brekelmans, Beijaard, & Korthagen, 2009; Tarc, 2007). Much of the learning teachers do after their initial pre-service training takes place on the job, outside of structured, formal settings (Blau, Peled, & Nusan, 2014; Smaller, 2005; E. Wilson & Demetriou, 2007). This unstructured learning has been called both informal and

incidental learning; in practice, the two types of learning often happen alongside one another (Marsick & Watkins, 2001).

Informal learning is important, in part, because it happens so frequently. Livingstone (2012) conducted a comparative analysis of survey results spanning 12 years and including nearly 13,000 adult learners in Canada. Nearly 90% of the adults surveyed reported engaging in informal learning activities, with an average of 6 hours per week spent in informal learning related to their jobs. In a 3-year study of in-service teachers, E. Wilson and Demetriou (2007) found teachers participated in substantially more informal learning, in the form of conversations with colleagues and other types of informal networking, than formal learning. Teachers in the study engaged in learning prompted by situations they encountered in the classroom and preferred informal modes of problem solving to more deliberative modes. This is consistent with Attard's (2007) conclusions from a yearlong autoethnography in which he observed that his teaching habits were more likely to change when he engaged in informal learning for the purpose of solving a problem of practice. Likewise, after multiple studies of informal workplace learning, Eraut (2004) concluded that informal learning happens more frequently than formal learning in the workplace.

Teachers' informal and incidental learning are also ongoing throughout their careers. In a survey of 166 public school teachers' informal learning activities, Lohman (2005) found nearly all of the teachers in the study (98%) reported engaging in informal learning activities such as sharing resources with colleagues, scanning professional magazines or journals, and talking or collaborating with others. In further analysis of the same survey responses, Lohman (2006) found most teachers in the study preferred

interpersonal modes of informal learning, such as talking and sharing ideas with colleagues, to independent modes of informal learning, such as reading articles or searching the Internet. Similarly, in a multiple case study of four teachers in the Netherlands, Hoekstra and colleagues (2007) found all four teachers frequently engaged in informal learning while engaged in classroom teaching. Applying Eraut's (2004) typology of informal workplace learning, the researchers found multiple examples of teachers' deliberative and reactive learning, including experimenting with new teaching practices before reflecting on whether or not they were successful or setting aside time to read more about a topic related to their teaching.

Informal learning in the workplace may take several forms, but many researchers agree with Marsick and Volpe (1999) that it shares several characteristics: it is job-embedded, triggered by a need to solve a problem, involves action and reflection, and is connected to others' learning (p. 5). Teachers' informal learning needs to be differentiated based on teachers' learning preferences and teaching styles (Hoekstra et al., 2009). It is important to note, like other kinds of teacher learning, teachers' informal learning is context-dependent; in fact, Marsick and Watkins (2001) and their colleagues eventually formally expanded their theory of informal and incidental learning to include the context of the organization in which learning occurs (Marsick, Watkins, Callahan, & Volpe, 2006). Subsequent studies have supported the importance of context in reference to teachers' informal and incidental learning. Recall that Lohman (2006) analyzed survey responses related to teachers' learning. He concluded the high degree of interactive informal learning reported in some responses was highly workplace dependent, an effect exacerbated at the secondary level, where organizational structures made teacher

isolation more likely. Similarly, Burns and Schaefer (2008) conducted a 3-year study of 50 teachers enrolled in an alternative certification program for Trade and Industrial licensure. The teachers in the study engaged in substantial amounts of informal learning, but the researchers pointed to a need to understand not only more about how informal learning can be supported and developed in the workplace, but also the contextual factors that influence informal learning. Likewise, when Schei and Nerbø (2015) studied a group of 10 Norwegian preschool teachers and their assistants, they found the teachers regularly engaged in informal learning activities, such as asking colleagues for advice, reflecting on their own practice in order to solve a problem, or observing the ways colleagues dealt with challenging classroom situations. However, their assistants found informal learning more challenging, in part because they had fewer opportunities to interact and collaborate with colleagues and enjoyed less autonomy in deciding how to use their time. In each case, context influenced the quality of and opportunity for informal and incidental learning.

Although the many benefits of informal learning have been well established, there might also be some less obvious limitations of informal learning. However, it is possible with formal supports, some of these challenges may be mitigated, allowing for more robust and sustainable models of informal teacher learning to flourish. Along with considerations of the best ways to support teachers' informal learning come considerations of context: What role does context play in teacher learning? In the following sections, I will address each of these related subtopics more deeply—the advantages and limitations of informal learning, formal supports for informal learning, and the role of context in teachers' informal learning.

Advantages of informal learning. Support that comes "just in time" is an important advantage of informal learning (W. M. Jones & Dexter, 2014): teachers get the help they need when they need it, rather than having to wait for a formally scheduled professional development session. For some learners, this type of support for learning might be more important than formal learning (Eraut, 2004). Informal learning groups, such as social networks, offer immediate access to new ideas and solutions to problems (Carliner, 2012). They can also serve a valuable role in demonstrating workplace norms and culture for novices. In this way, informal learning is highly individualized, with learners incorporating new information "in ways that relate to their own circumstances, previous knowledge, and current needs" (Carliner, 2012, p. 112), something that does not always happen in more formal learning activities. In his brief chapter about the value of community based learning, Kendall (2004) offered two advantages of informal learning: it is often low-cost or free and it does not rely on any official qualifications from either the learner or expert. Of course, this latter point could also be seen as one of the limitations of informal learning, which I will discuss further in the next section.

Informal learning might also lead to broader and more innovative learning than formal learning alone (Bolt, 2012). When Bolt compiled the results from three Australian studies of teachers' professional development, she concluded the flexibility of informal learning methods—especially with respect to asynchronous communication with colleagues around the globe—allowed teachers to develop wider circles of collaboration than they would otherwise have formed. This in turn seemed to lead to higher levels of innovation and experimentation in the classroom. The widespread use of digital tools may enhance this effect. In their conceptual analysis of informal learning as mediated

through digital environments, Za and colleagues proposed that online tools like video sharing services allow teachers to learn with and from each other along increasingly diverse pathways (Za, Spagnoletti, & North-Samardzic, 2014). In other words, digital tools, in particular, might enhance the asynchronous and geographically independent benefits of informal learning.

Finally, there is evidence teachers may simply prefer informal learning to formal learning. Smaller (2005) collected data on more than 500 Canadian teachers' informal learning activities and found 58% of the teachers in the study preferred informal learning to formal learning; only 20% preferred formal learning, with the remainder of those sampled either abstaining or indicating no preference between the two types of learning. In a similar 10-year study of Canadian teachers' informal workplace learning, Tarc (2007) found teachers in the study were often very positive about the impact of informal learning experiences on their teaching practice. This could be, in part, because the transfer from learning to practice may be greater with informal learning than with formal learning (Grosemans, Boon, Verclairen, Dochy, & Kyndt, 2015). When Lohman (2003) interviewed 22 tenured teachers from across grade levels and content areas about their informal learning, the teachers reported a major advantage of informal learning versus formal learning was that it allowed them to go beyond the limited scope of generic, formal professional development sessions to meet their own learning needs. Further, although there is plentiful research to support the value of collaborative learning, in practice, many adults might actually be engaging in more individual learning (Webster-Wright, 2009, p. 721). This individual learning is more likely to happen along informal pathways, which are often close at hand and free to access.

Limitations of informal learning. One limitation of informal learning comes with trying to create and maintain the delicate balance of learner-directed experiences with sustained momentum that may require external supports or interventions. For example, recall from the discussion of PLNs that these networks offer the advantage of asynchronous communication. The downside to this, however, is that teachers must learn "new norms and strategies for interacting" (Putnam & Borko, 2000, p. 11) in these environments—skills they might not have the expertise to develop on their own. With respect to the online community created by a PLN, there is also a bigger question to consider: When teachers participate in a virtual informal learning community, does this come at the expense of participating in the physical informal learning community within their own school organization? (Putnam & Borko, 2000). In other words, there might be negative impacts on teachers' workplace collaboration if their informal learning needs are being met exclusively online.

Research is conflicted about the role teachers' years of work experience might play in their motivation to participate in workplace learning. Some researchers have suggested that the increased confidence that comes with years of experience might result in a decreased desire for ongoing professional learning (Doornbos, Simons, & Denessen, 2008). Others have found that membership in online social networks and other avenues for informal learning might be limited to those teachers who are particularly motivated to pursue additional learning (Marklund, 2015), leaving reluctant or struggling learners to rely solely on formal learning opportunities. The lack of consensus as to the effects of experience on teachers' learning might suggest a need for differentiated approaches to

ensure novice and veteran teachers alike have the opportunity to engage in ongoing professional learning.

Another potential downside of informal learning might be that teachers in particular are unlikely to view themselves as learners and to prioritize their own learning over that of their students (Hoekstra et al., 2007). This means they might spend unstructured time grading papers or planning lessons for students rather than engaging in informal learning related to their teaching. Or, they might use the time inefficiently, unsure of which sources of information will be most useful and relevant to them. Informal learning requires time (Lohman, 2005) and without formal supports to protect this time, it might be difficult for teachers to arrange their schedules to allow for their own informal learning.

Formal supports for informal learning. In recent years, a recurring theme has emerged in the research around informal learning: formal structures and supports might be needed for learners to capitalize on the benefits that might be derived from informal learning (Hoekstra & Korthagen, 2011; W. M. Jones & Dexter, 2014; Tarc, 2007). Marsick and Watkins (1992) have stressed the importance of providing adult learners with explicit instruction about informal learning and the structures that support it. That is, teachers might need to receive formal instruction in how to go about learning informally and in the types of routines, structures, and habits that support and foster informal learning. Recall from a previous section, this idea relates to findings from S. M. Wilson and Berne (1999): the best formal professional development activates teacher learning so teachers have a desire to continue their learning on their own. This also aligns with what Putman and Borko (2000) concluded after a review of the literature related to teacher

learning: providing new avenues for teacher communication without any corresponding formal support structures was unlikely to change the ways teachers communicated (p. 11). Similarly, many of the 22 teachers in Lohman's (2003) study of teachers' informal learning reported the primary benefit of the formal professional development sessions they participated in was the opportunity to share ideas and reflect on practice with their colleagues outside the bounds of the formal learning agenda. In each case, formal structure either directly or indirectly supported teachers' informal learning.

In addition to direct instruction about how to learn informally, teachers also need the organizational supports that will make ongoing learning possible. Like Lohman (2003), W. M. Jones and Dexter (2014) found teachers' informal learning was often triggered by a formal professional development session. For example, teachers might attend a formal professional development session in a whole group format, but then continue talking about the ideas presented in informal groupings throughout the following week. These informal conversations might lead to informal learning. In this way, the informal and the formal were complementary. However, such conversations cannot happen without formal supports such as protected time to converse with colleagues and a shared culture of professional learning. In a study of 16 first-year teachers, researchers found that a school culture that celebrates lifelong learning and includes new teachers in informal learning was key to supporting novice teachers (McCormack et al., 2006). The researchers recommended school leaders commit to limiting the extracurricular responsibilities of novice teachers, avoiding the practice of assigning them the least desirable tasks or teaching assignments and restricting novice teachers' tendency to overcommit to non-teaching tasks. They found many of the

teachers in their study felt overwhelmed by these non-teaching tasks and identified them as a barrier to their ongoing professional learning (McCormack et al., 2006).

A survey study of 473 Dutch police officers' informal workplace learning also has bearing here. Researchers found the amount of informal learning that happened in the workplace was only partially related to individual characteristics, such as desire to learn and years on the job (Doornbos et al., 2008). They found a substantially stronger connection between informal learning and workplace characteristics, such as how much autonomy officers had on the job. This is similar to findings by Schei and Nerbø (2015), in their study of preschool teachers and their assistants, that greater teacher autonomy led to greater amounts of informal learning. Likewise, Hastie and colleagues (Hastie, MacPhail, Calderón, & Sinelnikov, 2015) conducted a multiple case study of three teachers from Ireland, Spain, and Taiwan and found all three needed ongoing, autonomous access to outside experts even after formal training had ended, in order to maximize the benefits of their professional learning. In short, in order to support teachers' informal learning, schools must be structured in ways that support collaborative, on-demand, just-in-time learning.

Some researchers have suggested specific strategies educational leaders can follow to provide support for teachers' informal learning, including assigning novice teachers to classrooms located near experienced teachers, protecting teachers' unstructured planning time to allow them to participate in informal learning activities, and ensuring teachers have adequate time to interact with same-subject or same-grade-level colleagues (Lohman, 2000, 2006). Some of the suggestions from the trade magazine

Talent Development ("Four ways to facilitate informal learning," 2012) might apply to educators. The writers suggest that organizational leaders create:

- a curated collection of digital apps or resources so employees do not have to waste time searching and testing on their own.
- a wiki or blog for employees to contribute to and learn from.
- physical products, like handouts and brochures, to serve as learning aids for frequent or cumbersome tasks.

A recent proposal about supporting and evaluating informal learning in the workplace acknowledged the challenge of determining whether and how informal learning has occurred. As a means of addressing this challenge, the authors recommended employees maintain digital or physical informal learning portfolios they can mine for resources and share with colleagues (Galanis, Mayol, Alier, & García-Peñalvo, 2016). The authors suggested leaders can support this informal collaboration through the creation of a virtual environment where employees can share resources one-on-one, in small groups, or with the full staff, using digital tags to filter and sort relevant information.

In his book *Informal Learning Basics*, Carliner (2012) suggested employers plan and coordinate structured events, such as "lunch and learns…seminars and symposia" (p. 93) to maximize employees' opportunities for informal learning. He also emphasized the need for employers to help learners reflect on what they have learned and make a plan for transferring newly acquired knowledge to new situations. This aligns with findings from Bednall and colleagues (Bednall, Sanders, & Runhaar, 2014), who surveyed 238 Dutch teachers and school personnel about the ways performance appraisals affected their

informal learning activities. The participants in the study reported that high-quality performance appraisals—clear, honest feedback, given regularly—led to an increase in their informal learning activities like knowledge sharing with colleagues, reflection on their own practice, and innovation on the job. The researchers posited that high-quality appraisals might lead employees to feel more confident in directing their own continuing learning, and regular feedback might provide employers with more opportunities to serve as mentors, guiding employees toward useful continuing education pathways (Bednall et al., 2014).

Left to their own devices, not all teachers will naturally develop into expert informal learners; rather, some might need the support of their workplace culture and school leaders to realize the full potential of informal learning opportunities (Grosemans et al., 2015). Formal structures, such as common planning times, might support teachers' informal learning by allowing time for collaboration, troubleshooting, and sharing of ideas (W. M. Jones & Dexter, 2014). Because each school environment is unique in many ways, and the supports it offers for teacher learning vary widely, context is increasingly understood to have an important role to play in teacher learning. This might be especially true in the case of teachers' informal learning.

The role of context. In addition to formal supports for informal learning, Marsick and Watkins (2001) have suggested context might also play an important role in the development and fostering of informal learning in the workplace. Context includes not only the physical location where learning occurs (Putnam & Borko, 2000), but also the implicit assumptions and expectations about learning unique to each workplace (Webster-Wright, 2009). E. Wilson and Demetriou (2007) conducted an extensive review of

literature related to the contextual factors that impact teacher learning and paired this research with preliminary findings from their ongoing longitudinal study of teachers' learning. They found that a supportive work environment, with colleagues who offer encouragement and advice, might enhance teacher learning across the continuum of formal to informal learning. Similarly, Richter and colleagues (2011) concluded that in school contexts characterized by a high degree of teacher engagement, teachers were more likely to pursue informal learning opportunities independently. This is also reflected in Eraut's (2004) research: he found informal learning required "a group climate of learning" (p. 268), including factors such as how work is allocated and structured; the types of expectations workers are given related to their role, performance, and progress; and the types of encounters and relationships that exist among colleagues (p. 269). Researchers conducting studies across grade levels and countries have found teacher learning, regardless of its level of formality, is context specific (Jurasaite-Harbison & Rex, 2013; Lohman, 2006; Marsick et al., 2014; Opfer & Pedder, 2011).

It is also important to consider the influence of the physical context where teacher learning takes place. In other words, the building, classroom, or digital space where learning happens might play a role in the quality of the learning that takes place. After a review of the literature related to teacher learning, Putnam and Borko (2000) concluded that where teachers' learning happens might influence how and how much they learn. In some cases, a novel context might be needed in order to override existing bias or culture; in others, it might be necessary for teachers to learn in the same context in which they will be teaching (i.e., their classrooms) in order to overcome the challenge of knowledge transfer (Eraut, 2004; Putnam & Borko, 2000). In another example of the importance of

physical location to teacher learning, Levenberg and Caspi (2010) surveyed 239 Israeli elementary school teachers about their experiences with formal and informal learning, both online and face-to-face. They concluded the medium was more important to teachers' informal learning than it was to their formal learning experiences. In short, both the cultural and organizational contexts, as well as the physical contexts where learning occurs, play a role in the effectiveness of teachers' informal learning.

The Continuum of Teacher Learning: From Formal to Informal

One widely held perspective is that formal and informal learning are on a continuum, with a range of (in)formality present throughout that spectrum (Burns, 2008; Eraut, 2004; Grosemans et al., 2015). If formal learning, like professional development, is that which is led by an instructor who is presumed to have more knowledge and expertise about a subject than the learners who participate in the formal learning process, then informal learning is that which is either led by the learner, who might seek knowledge in a variety of places and forms, or is led by an instructor outside the bounds of any organized body of knowledge (Livingstone, 2007). For example, if one teacher in a school learns a shortcut for using the new gradebook software and shares the information over lunch with colleagues who have expressed frustration with the software, those colleagues might have engaged in informal or incidental learning.

Another perspective is that, although professional learning begins in formal settings, such as the university classroom, when learning is applied, informal modes of learning take over, guiding teachers as they confront novel problems in the classroom context (Marsick et al., 2014). Professionals, including teachers, learn both as individuals and through collaboration with others (Marsick et al., 2014). Likewise, teachers learn

along many pathways. Researchers agree teacher learning as a whole is "fragmented" (S. M. Wilson & Berne, 1999, p. 197) and requires teachers to work hard (DuFour, 2004). Further, it is unlikely any one modality of teacher learning will satisfy all problems of practice teachers encounter throughout their careers; rather, teacher learning must be tailored to the context and the specific problem being addressed (Opfer & Pedder, 2011; Putnam & Borko, 2000).

Informal and incidental teacher learning happen across content areas, grade levels, and contexts. Yet, when compared to the body of research on formal modes of teacher learning, there is relatively little current research about teachers' informal and incidental learning, especially as it relates to the application of specific knowledge and skills. In short, researchers know much more about the processes and outcomes of teachers' formal professional learning than about the "content, processes, and outcomes of ongoing, informal workplace learning" (Little, 2006, pp. 1–2). One specific context for teacher learning that has received increasing attention in recent years is teachers' learning related to technology integration. Recent research suggests that many of the ways teachers learn about technology integration have more in common with informal learning modalities than formal ones.

Teachers' Technology-Related Learning

Teachers' technology-related learning is increasingly understood to require a highly complex and nuanced set of knowledge and skills. Although researchers agree that teacher learning, formally and informally, is happening, effective teacher learning related to technology integration might not be. For example, the U.S. Department of Education and the National Center for Education Statistics (2012) reported that although more than

98% of teachers had participated in some form of professional development during the 2011-2012 school year, only about 66% of teachers had participated in professional development related to using computers in the classroom. This means a third of teachers reported receiving no professional development at all related to using computers in the classroom. The lack of technology-focused professional development is particularly striking when one considers that, by 2009, 97% of teachers in the U.S. reported the presence of classroom computers; 93% reported constant access to the Internet with those computers (Gray, Thomas, Lewis, & Tice, 2010).

This disconnect might be related to earlier findings from Lawless and Pellegrino (2007) who conducted a comprehensive review of the literature related to teachers' technology professional development and found that, despite the ubiquitous presence of technology in the classroom, it "is often poorly integrated with other classroom instructional activities" (p. 580). Likewise, when Zhao and Bryant (2003) compared findings from two previous studies of technology integration professional development, they found teachers from both studies felt frustration with one-size-fits-all training models that were not adapted to their prior knowledge or learning interests. Instead, the teachers wanted ongoing, individualized support to help them integrate technology effectively. In line with these studies, the Office of Educational Technology and the U.S. Department of Education (2016) have reported a need for teachers to have "continuous, just-in-time support that includes professional development, mentors, and informal collaborations" (p. 25) when learning to integrate technology. Teachers' learning about technology integration might require the flexibility of multiple learning pathways, along the formal to informal continuum.

The belief of many educational policy makers seems to be that providing abundant access to technology will lead to effective integration of technology by teachers, which, in turn, will lead to improved student learning; however, this is not the case (Cuban, Kirkpatrick, & Peck, 2001). Cuban and colleagues (2001) conducted an in-depth qualitative study of two technology-rich high schools located in California's Silicon Valley. After 7 months of extensive interviews, observations, surveys, and document analysis, the researchers concluded teachers did not have time to explore and learn new technologies on their own, but the training provided by the schools was generic and removed from teachers' specific contexts. Further, the context and structure of U.S. high schools is so rooted in historical patterns and ways of thinking, it might not be conducive to integrating new technologies. In short, access alone did not lead to integration; teachers needed specific knowledge about how to teach effectively with technology (Cuban et al., 2001). This mirrors caution from the Office of Educational Technology, that novice teachers in particular might be entering the profession ill prepared to teach with technology:

> It is inaccurate to assume that because pre-service teachers are tech savvy in their personal lives they will understand how to use technology effectively to support learning without specific training and practice. This expertise does not come through the completion of one educational technology course separate from other methods courses but through the inclusion of experiences with educational technology in all courses modeled by the faculty in teacher preparation programs. (Office of Educational Technology & U.S. Department of Education, 2016, p. 33)

Note that this caution was issued in 2016, suggesting that the earlier conclusions from researchers like Cuban and colleagues (2001), Zhao and Bryant (2003), and Lawless and Pellegrino (2007) are still relevant.

Many teachers are learning to integrate technology in ways that are closer to the informal, rather than formal, end of the continuum. For example, O'Hara and colleagues (O'Hara, Pritchard, Huang, & Pella, 2013) studied 16 upper elementary school teachers in California who had self-identified as either beginning users or non-users of educational technologies. The teachers participated in 56 hours of professional development sessions that were evenly divided between "explicit instruction" related to technology integration, "individual and collaborative experimentation," (O'Hara et al., 2013, p. 207) and hands-on practice. Overall, the professional development program placed a heavy emphasis on peer support, including the creation of a wiki for teachers to use for collaboration between their face-to-face sessions. After interviewing the teachers in the study, the researchers concluded that even the formal components of this professional development effort needed to evolve and be responsive to teachers' needs and interests. They also found teachers in the study valued structured, planned opportunities to collaborate with and train one another; this peer mentoring, coupled with the expert guidance of the professional development facilitators, increased teachers' levels of confidence integrating technology in the classroom and led to a desire for continued learning (O'Hara et al., 2013). Similarly, when Mouza (2002) studied three teachers who had participated in 12 weeks of technology integration professional development, she found that both administrative support and peer collaboration were major factors in teachers' successful technology integration. She concluded, "modeling, discussion, brainstorming of ideas,

hands-on [activities], and just-in-time support" along with "adequate time to discuss and reflect" (Mouza, 2002, p. 285) were needed for effective technology integration professional development. Recall from previous sections that many of these elements are examples of informal learning.

These findings are not limited to novice users of educational technology. Vu (2015) studied 21 elementary and secondary teachers whose principals had identified them as "technology savvy" (p. 10). The teachers were learning to integrate iPads in the classroom. All of the teachers in the study reported that informal learning—such as sharing ideas with colleagues—was essential for successful technology integration; twelve of the teachers relied exclusively on informal learning since their schools did not offer any formal learning opportunities related to integrating the iPads into instruction. Vu (2015) concluded that technology integration training should be on ongoing process that combines both formal and informal learning opportunities. Similarly, when researchers studied a group of 53 middle and high school math teachers who were learning (in part) to integrate a new math software into the curriculum, teachers reported wanting more time to explore technology independently, more time to learn from their colleagues about using the technology, and more structured opportunities to share ideas (Matteson et al., 2013). Again, many of these types of teacher learning are informal.

Informal learning might play an especially important role in teachers' technology-related learning when the technology is new. Kessler (2007) surveyed 108 teachers who had participated in training to use Computer Assisted Language Learning software. At the time of the study, the software was very new and there were few formal resources available for teachers to learn from. Teachers in the study reported that the majority of

what they learned about using the software came through informal means, including talking with colleagues at professional conferences, collaborating with colleagues online, and subscribing to email LISTSERVs related to using the software in the classroom. At least in part because so little formal training was available, the teachers in the study perceived their informal learning opportunities to be more important than the limited formal training they participated in (Kessler, 2007). Likewise, in settings where teachers have very limited access to educational technology, informal learning might play an important role. Voogt (2010) studied 32 science teachers working in rural Russia. The teachers participated in a blended professional development program that included in-person workshops and activities as well as online collaboration with colleagues. The online collaboration component was challenging—only one of the teachers in the study had home Internet access and some did not have school Internet access either. Yet, the teachers in the study universally reported that, despite the difficulties presented by their lack of Internet access, they valued the learning that happened in their online discussions. They reported that, although the formal training components were adequate to increase their comfort level with the mechanics of using technology in the classroom (e.g., turning on the computer and opening the software program), they relied on their informal learning from colleagues to integrate technology into their teaching. In particular, the teachers in the study valued their opportunities to reflect and share ideas with colleagues and clarify what they had learned during formal training sessions, even after returning to their remote, rural schools (Voogt, 2010).

One key feature of informal learning, learning through collaboration with colleagues, might be especially important for teachers who are learning to integrate

technology in the classroom. Collinson and Cook (2004) studied 10 elementary and middle school teachers who were learning to use computers for instruction. The teachers in the study learned and shared knowledge about technology integration largely through their informal interactions with colleagues. They also reported learning through independent exploration and trial-and-error, but almost all of their technology integration learning occurred outside of formal spaces and scheduled meetings. However, the teachers who taught in a school with structured, common planning time were an exception. Teachers from this school valued this formal support for their informal learning and reported they preferred learning about technology integrating with trusted colleagues. The researchers concluded that teachers' sharing of technology integration knowledge "tended to be informal, specific, and exchanged in small doses" (Collinson & Cook, 2004, p. 130). In short, the teachers in this study relied heavily on informal modes of learning to integrate technology in the classroom.

In a study of 22 tenured teachers across grade levels and content areas, Lohman (2003) found pressure to integrate technology, combined with a lack of adequate formal training opportunities, often drove teachers toward informal learning pathways. The pressure to integrate technology into their teaching, combined with what is known about the inadequacy of many formal professional development opportunities, means there might often be a need for teachers to learn informally about technology integration in order to fill in the gaps left by other modes of learning. In Smaller's (2005) survey of over 500 Canadian teachers, 89% of the teachers reported learning new computer skills informally in the past year, compared to only 37% through formal learning modes. Likewise, in a study of 47 school librarians, more than half of the study's participants

reported relying on informal, workplace learning, rather than formal professional development, to learn new technology skills (Deissler et al., 2015). This included learning how to teach other adults and students to use technology as well as teaching themselves how to navigate social media and understand its impact on teaching and learning. Other researchers have suggested workplace training related to computer use might have declined in recent years due to an assumption that computers' ubiquity has rendered unnecessary the task of training workers on how to use them (Livingstone, 2012). Again, there is an underlying and erroneous assumption that providing access to technology is equivalent to its effective use (Cuban et al., 2001). Certainly, educational technology represents a great deal more than using computers in the classroom, but these ideas are representative of a larger trend: formal teacher learning does not always extend to teacher learning about technology integration (Deissler et al., 2015). There might be a need for teachers to supplement their formal learning about technology integration with informal learning.

Conclusion

Teacher learning is complex, multi-faceted, and context-specific. Formal learning in the form of professional development might not always meet teachers' learning needs. At its best, professional development is characterized by ongoing, job-embedded, individualized instruction. However, even when these conditions are met, teachers often need to pursue other learning pathways to fill in the gaps left after participating in formal learning. Simply put, formal professional development is often inadequate to meet all of teachers' diverse learning needs.

Communities of practice, where a network of practitioners work to improve their practice might be one avenue to fill in those gaps; yet, there is no consensus about the best way to form and maintain successful communities of practice and they might not be practical for all teachers. Another learning pathway, PLCs, offers ongoing, collaborative, data-driven opportunities for learning. However, PLCs require intensive time commitments and ongoing formal support by schools and often necessitate school wide cultural shifts that might not be feasible for all teachers. Similarly, PLNs offer an even less formal pathway for teacher learning. PLNs are user-directed, multi-dimensional collections of resources that might meet many of a teacher's learning needs. Yet, to be useful, they must be continuously maintained, even in the absence of a specific learning need. None of these pathways, in isolation, will satisfy all of a teacher's learning needs.

Truly informal learning is on-demand, asynchronous, and inherently individualized. It requires little in the way of ongoing maintenance, although it might require the formal support of school leaders to be successful. Informal and incidental learning represent promising pathways for teachers to address otherwise unmet learning needs. In particular, informal and incidental learning might help fill any gaps left behind after formal professional development for teachers learning to integrate technology in the classroom (Blau et al., 2014). Holcomb (2009) has suggested effective professional development for teachers learning to integrate technology is job-embedded, structured, ongoing, reflective, and collaborative. These are many of the same features that characterize informal and incidental learning in the workplace (Marsick & Volpe, 1999). The widespread use of technology in the classroom, coupled with established importance of teachers' ongoing, job-embedded, self-directed professional learning opportunities,

points to the need for further research about teachers' informal learning in technology-rich environments.

Chapter 3: Methods

As the literature reviewed in Chapter 2 illustrated, relatively little is understood about how teachers learn informally and incidentally about technology integration. In planning my study, it was therefore appropriate to consider a research approach that allowed for a broad search for meaning and the potential to understand this concept more fully. Both Marsick and Watkins (2001) and Callahan (1999) have pointed to a need for further exploratory studies of informal and incidental learning. Callahan (1999) recommended that future researchers consider how informal learning happens differently in different environments, or contexts. She suggested that future researchers might explore the types of organizational structures that enable or inhibit informal learning in the workplace. Marsick and Watkins (2001) proposed studying the ways online learning might alter adults' informal and incidental learning, providing greater and more immediate access to information. Yet, thus far, additional research with these foci has been sparse.

My study included elements of all of these recommendations: exploring teachers' informal and incidental learning, specifically as it relates to technology integration; delving into the various ways teachers learn from a variety of sources, including digital and online sources; considering how informal and incidental learning are (or are not) influenced by context; and examining the types of formal supports for learning that might encourage or inhibit teachers' informal and incidental learning. This exploration involved

learning more about the experiences of teachers who were learning to integrate technology in their classrooms along a variety of pathways, such as those foreshadowed by Miles, Katherine, Elaine, Cheri, and Jeff in Chapter 1. Through observations of and conversations with teachers, I learned more about their informal and incidental learning related to technology integration.

Theoretical Framework

My primary research interest was teachers' informal and incidental learning, specifically about technology integration. Current understandings related to informal and incidental learning in the workplace are heavily influenced by the research of Marsick and Watkins (1992, 2001) and Livingstone (2007, 2012). Recall from the "Informal Learning" section in the previous chapter that informal learning is "intentional but not highly structured" (Marsick & Watkins, 2001, p. 25) learning that occurs in response to a problem or need for more information and that it is active and intentional (Livingstone, 2007). Marsick and Watkins (2001) characterized informal learning as "self-directed learning, networking, coaching, mentoring, and performance planning that incudes opportunities to review learning needs" (pp. 25–26). These examples guided my analysis of the learning that teachers in my study reported.

Incidental learning is learning that occurs haphazardly, spontaneously, or along the way to solving an unrelated problem (Marsick & Watkins, 2001). Marsick and Watkins (2001) characterized incidental learning as that which might, at first, be taken for granted, but that can be "probed and intentionally explored" (p. 26) once it is remembered. Examples include "the hidden agenda of an organization's culture or a teacher's class, learning from mistakes, or the unsystematic process of trial and error" (p.

26). Although informal and incidental learning are distinct processes, it is often hard to separate incidental learning from informal learning and one often leads to the other (Marsick & Volpe, 1999). For this reason, I expected to—and did—encounter informal and incidental learning alongside one another as teachers shared their experiences related to learning about technology integration with me.

For the most part, I did not expect the teachers in my study to differentiate between their own informal and incidental learning; rather, I expected that my analysis of what they shared would lead me to draw distinctions. In many cases, this was true. Teachers in my study routinely conflated informal and incidental learning. However, I observed as the study progressed that some participants did begin to differentiate and reflect on their own learning, making comments like, "I guess that was informal learning," or, "That was purely incidental—I just stumbled across it." Still, in most cases, it was my own analysis of teachers' learning experiences that created a distinction between their informal and incidental learning experiences. And, as I will discuss further in Chapter 5, teachers in my study learned along many pathways; often they learned informally and incidentally at the same time. Overall, in coding the examples participants shared with me, I was guided by the theory that informal and incidental learning are contextually influenced, unstructured, sometimes unplanned, learning opportunities that take many forms, but are, in general, learner-directed and able to be recalled and reflected upon at a later date.

Research Paradigm

I used a qualitative research approach to conduct this study. Qualitative inquiry is characterized by (at least) four philosophical assumptions: there are multiple versions of

reality; understanding those versions requires the researcher to interact closely with participants; the researcher brings his or her own perspective, and thus biases, to the inquiry process; and the methods are "inductive, emerging, and shaped by the researcher's experience" (Creswell, 2013, pp. 21–22). Specifically, my research took an exploratory approach and relied on the research paradigm of social constructivism.

Social constructivism is the perspective that "individuals seek understanding of the world in which they live and work" (Creswell, 2013, p. 24). It includes the belief that there are multiple, equally valid versions of reality co-existing in the world (Ponterotto, 2005). Further, those realities are shaped through individuals' interactions with others (Cottone, 2007). In short, social constructivists believe that, through social interactions, individuals construct an understanding of reality that is unique to them. Researchers who work within the paradigm of social constructivism use open-ended questions to explore participants' experiences (Creswell, 2009). They believe that, in this way, researchers and participants can "co-construct" findings through dialogue (Ponterotto, 2005, p. 130). Notable for my research purposes, this paradigm includes consideration of "the specific contexts in which people live and work" (Creswell, 2009, p. 8). I worked with my participants to understand their experiences of their informal and incidental learning related to technology integration, nested within the contexts of their workplaces. Like other paradigms associated with qualitative research, social constructivism also specifies that the researcher position herself within the research, considering how her own past experiences might have shaped her perspective (Creswell, 2009). These characteristics of social constructivism—reliance on open-ended questioning to understand participants'

experiences, a consideration of specific contexts, and a concern for the researcher's role in interpreting those experiences and contexts—were well suited to my research focus.

Moving from theoretical notions of a research framework and paradigm, into the concrete ideas of conducting my study, I next discuss my research approach, including the specific methods I used to generate and analyze data.

Research Approach

One research approach that readily lends itself to broad, exploratory methods is that of phenomenology. A research approach is both a plan for how to proceed with research and an openness to staying flexible and being guided by what is encountered (Vagle, 2014). Vagle contends that defining a research approach "allows us…to have parameters, tools, techniques and guidance, but also allows us to be creative, exploratory, artistic and generative with our craft" (p. 48). My goal was to understand, in a nuanced and in-depth way, the phenomenon of teachers' learning, along informal and incidental pathways, to integrate technology. This goal led me to consider a research approach based on exploring and understanding a particular phenomenon. Vagle (2014) has defined phenomena as follows:

> Phenomena are the ways in which we find ourselves being in relation to the world through our day-to-day living. Therefore the primary purpose of phenomenology as a research methodology stemming from its philosophical roots is to study what it is like as we *find-ourselves-being-in-relation-with-others* [emphasis in original] (e.g., teacher with students, nurse with patient, therapist with client) and *other things* [emphasis in original] (e.g., a good book, some bad news, our favorite activity, an anxiety). (Vagle, 2014, p. 20)

Phenomenological research is designed for the purpose of exploring and understanding a particular phenomenon. Vagle (2014) has emphasized that phenomenological research focuses not on the individual, but on the phenomenon; in this case, my focus was on the informal and incidental learning teachers did, more so than on the teachers themselves. To put this in Vagle's terms, I was seeking answers to the question: How do teachers find themselves learning informally and incidentally about integrating technology? My goal was to understand teachers' informal and incidental learning about technology integration through the teachers' lived experiences. A focus on the individual teachers would not have afforded me a holistic understanding of the phenomenon, so I looked across their individual experiences to build a multi-faceted understanding of this phenomenon.

Characteristics of phenomenological research. Phenomenology is concerned with identifying and describing the subjective experiences of participants. It involves examining experiences from the participants' points of view (Schwandt, 2007, p. 226). The goal of phenomenological research is to "identify the 'essence' of a phenomenon though an individual's experience of that phenomenon" (Bazeley, 2013, p. 193). With phenomenological research, the researcher strives to understand a phenomenon, in as complete and nuanced a manner as possible, by gathering data related to participants' lived experiences of that phenomenon.

An important concept within the tradition of phenomenological research bears further exploration here: *bracketing*. Bracketing (and the related concept, *bridling*) refers to the researcher's ability to separate personal experiences related to the phenomenon being studied from present observations of the phenomenon (Vagle, 2014). For example, in conducting my research I had to set aside opinions and impressions borne out of my

past experiences both as a teacher-learner and as a technology educator so I could be open to all of the ways the participants in my study were experiencing the phenomenon of informally and incidentally learning to integrate technology. In my Researcher as Instrument statement (Appendix A), I reflected on these experiences and the ways they might influence me as an observer and researcher during this study. I also, as Bazeley (2013) suggested, answered for myself the questions I used to guide my participant interviews. I incorporated my analysis of these answers in my Researcher as Instrument statement as a further means of bracketing my own experiences from those my participants might have shared.

Vagle (2014) stressed that the researcher need not try to forget past experiences, but rather should acknowledge them and attempt to disconnect from any influence those experiences might have on current observations. Vagle delineated a distinction between bracketing and the related concept of bridling; in short, bracketing focuses on the researcher's past experiences while bridling encourages the researcher to slow down interpretations and resist forming judgments until research is complete. Concisely, "bridling is an active project in which one continually tends to the understanding of the phenomenon as a whole throughout the study" (Vagle, 2014, p. 67). Because bracketing and bridling are key features of phenomenological research, I also selected quality criteria that encourage a methodical and reflective approach to the research process; I discuss these further in the section "Quality Criteria," later in this chapter. The characteristics of phenomenological research further guided me in selecting participants for my study and in choosing methods for generating and analyzing data.

Participant Selection & Research Setting

Vagle (2014) recommended letting the phenomenon guide the sample; in other words, if the phenomenon being studied requires a few in-depth, long-term observations, choose a few participants. Likewise, if it requires a wide variety of perspectives, more participants will be needed. Recall from Chapter 2 that informal learning is a frequent occurrence among adults in general (Livingstone, 2012) and teachers in particular (Lohman, 2005; E. Wilson & Demetriou, 2007). It was a fairly safe assumption, then, that most teachers engage in informal learning, at least to some extent. What is less understood is how teachers learn informally and incidentally about technology integration, specifically. It was this second parameter that primarily guided my selection of research participants.

I selected my participants through purposive sampling. Purposive sampling involves methodically choosing participants based on their "relevance to the research question" (Schwandt, 2007, p. 269). I planned to recruit teachers who were engaged in technology integration, at least to some extent. My purpose was to gain a complete, nuanced understanding of these teachers' informal and incidental learning about technology integration. For that reason, I sought a wide variety of teachers to participate—some who were relatively new to the profession and some with years of experience; some who were technology "power-users" and some who were novices or who were struggling with integration. It is not safe to assume that teachers who use technology sparingly are not actively learning about technology. Choosing not to use technology is also a choice and there might be relevant learning behind that choice (Phillips, 2016). Since my purpose was to understand this phenomenon as deeply as

possible, my primary goal in selecting participants was recruiting a heterogeneous sample. My reasoning was that the greater the variety of perspectives and experiences present in my sample, the more nuanced and complex my synthesis of the participants' lived experiences would be.

To further increase the diversity of perspectives around this phenomenon, I also sought both teachers who worked in schools with active learning communities, such as PLCs, and those who worked in schools without many formal supports for informal learning. Since the influence of context has been well established in the extant research related to informal and incidental learning (Marsick & Watkins, 2001), including consideration of participants' contexts in my selection criteria was appropriate. It was important that I find participants from a variety of schools—including those with and without formal, organizational supports for informal and incidental learning—and grade levels. This gave me the opportunity for additional insights into how the experiences of teachers' informal and incidental learning related to technology integration might differ (or not) across various contexts.

I worked with leaders from a local school division with whom I have an established relationship. The school division is relatively small, but each school building has a distinct and unique context, with a variety of levels of support for teachers' informal and incidental learning. Division leaders knew teachers well and were qualified to recommend teachers who fit my sampling criteria. After securing institutional permission from William & Mary's School of Education Internal Review Committee (EDIRC), I secured formal permission from the school division's superintendent to conduct my study with teachers in the division. Then, I asked division leaders for

recommendations of teachers who were using technology in the classroom and might be willing to talk with me about their learning. Concurrently, I emailed principals at each of the four schools in the division for additional recommendations. The principals made recommendations, but also forwarded my request to their staff members, soliciting volunteers for my study. I contacted the teachers who were nominated or volunteered in order to gauge their interest in participating in my study. I evaluated each nominee's "fit" with my sample's criteria by asking myself several questions about each potential participant: Is this teacher integrating technology, at least to some extent? Is this teacher willing to share with me about his or her informal and incidental learning related to technology integration? Based on what I know about this teacher, will he or she have time to meet or talk with me several times over the next few months? Is this teacher's teaching context the same as or very similar to any other potential participants?

After reaching out to over 20 potential participants, I narrowed the field to about a dozen who had strong potential as participants. These dozen teachers expressed interest in participating in my study; were using technology in the classroom, at least to some extent; and came from a variety of teaching contexts within the school division. As I exchanged emails and phone calls with these potential participants and described more about the requirements of participating in my study, seven teachers emerged as confirmed participants—the other five had reservations about the time required to participate in the study or had what I considered disqualifying characteristics. For example, one potential participant was a first-year teacher, with many demands on her time already; another was planning to begin maternity leave mid-way through my data generation timeline and had many additional duties and responsibilities related to preparing for her absence form the

classroom. I will introduce these seven participants and their teaching contexts in greater detail in Chapter 4.

Data Generation

Many previous researchers have noted the difficulties in accurately capturing the process of informal and incidental learning, represented as data (e.g., Galanis, Mayol, Alier, & García-Peñalvo, 2016; Marsick, Watkins, Callahan, & Volpe, 2006; Tarc, 2007). For example, Galanis and colleagues (2016) noted difficulties in validating and evaluating informal learning for the purposes of giving teachers credit for ongoing, job-embedded professional learning. In part, they found, this is because informal learning is "inconsistent, abstract and contextual in nature" (p. 600). Learners may follow many pathways to arrive at the same learning outcome, so there is no consistent set of criteria that can be used to document this learning.

Similar to Galanis and colleagues (2016), Tarc's (2007) research centered on a need to quantify and measure teachers' informal workplace learning in order to award them recertification credit for their job-embedded professional learning. He called for researchers to clearly define informal learning, drawing distinct boundaries between formal, informal, and incidental learning. The need to quantify and measure teachers' informal and incidental learning is outside of the scope of my research, but the challenges Tarc (2007) noted in observing teachers' informal and incidental learning have bearing on my study. Likewise, Marsick and colleagues (2006) have written that incidental learning is "difficult to observe, and when it is observed, it moves out of the incidental learning domain" (p. 799). They have also noted that the vast scope of resources available to learners makes it difficult to track the origin of learning.

Many of the aforementioned difficulties center on a common theme: observing informal and incidental learning is problematic. Researchers might do better to go straight to the source, asking the learner about the learning, rather than trying to witness the learning as it occurs. Because of this—and consistent with Tarc's (2007) recommendations—I focused on what teachers in my study reported about their informal and incidental learning experiences related to technology integration. I relied primarily on two forms of data generation: interviews and surveys that elicited participants' lived experiences and reflections about their informal and incidental learning related to technology integration.

These methods were consistent with phenomenological research (Vagle, 2014). Vagle has specified that interviews are an important and oft-used method for generating data in phenomenological research. Other methods include observations and written anecdotes (Vagle, 2014, p. 78). I also conducted one observation in each participant's classroom. However, due to the previously mentioned difficulties with observing informal and incidental learning, this was a secondary data source aimed at understanding teachers' contexts, rather than their learning, as I explain later in this section. I used brief surveys to generate the third type of data Vagle mentioned, written anecdotes. In the following sections, I describe how I generated data through participant interviews, observations, and surveys.

Interviews. Tarc (2007) has posited that research using job-embedded, individual interviews might help tease apart the subtle differences in teachers' formal, informal, and incidental learning. Vagle (2014) has encouraged phenomenological researchers to use unstructured interviews, but left open the possibility that the researcher will guide

questioning and discussion toward a focus on the phenomenon being studied. Unstructured interviews are "open and conversational" interviews designed "to find out as much as you can about the phenomenon from each particular participant" (Vagle, 2014, pp. 78–79). Vagle cautioned against over-reliance on *a priori* notions and lists of questions, since these might unintentionally shape participants' responses and reflections on their lived experiences. Yet, he acknowledged that unstructured interviews "can be more difficult to enact than a…semi-structured protocol" (Vagle, 2014, p. 79). To address this challenge, Vagle suggests that researchers—especially novice researchers—be guided by a firm understanding of the phenomenon they are studying and practice reining themselves in from conversational strands that are too far afield from their research focus. For this reason, and because I am a novice researcher, it was useful for me to refer to a list of guiding questions during my interviews (Appendix B).

In particular, I was interested in teachers' experiences related to informal and incidental learning, so I relied on guiding questions related to the theory of informal and incidental learning developed by Marsick and Watkins (2001). Although I referred to these questions as needed to prompt and guide my conversations with participants, they were not used as a script. I frequently deviated from these questions as needed, omitting and reordering them as appropriate, and I asked follow-up questions that were not included on this list, but were directly related to the phenomenon I studied. The content and sequence of my conversations with participants was guided by the lived experiences they chose to share with me related to their informal and incidental learning about technology integration.

I conducted 2-4 interviews with each participant over the course of the study. Typically, each interview lasted about 30 minutes, although some survey follow-up interviews were as short as 10 minutes and several of the final reflective interviews were as long as an hour. I interviewed 6 of the 7 participants at least 3 times; due to difficulties with scheduling separate interviews, I interviewed one participant only twice, combining survey follow-up questions and final reflection questions into one, longer interview. With participants' permission, I made audio recordings of each interview. My goal was data saturation—that is, learning enough about participants' experiences of the phenomenon of informal and incidental learning related to technology integration so that, eventually, no new information was being added to the categories of data that had emerged (Corbin & Strauss, 2008).

I took a staggered approach to data generation, completing my initial interview and observation with the first participant before scheduling my initial interview and observation with the next participant. After making a preliminary analysis of the data generated by this initial interview and observation (I discuss my methods for data analysis in greater depth in the next section), I moved on to an initial interview and observation with my second participant. After conducting preliminary analysis of the data generated with the second participant, I scheduled an initial interview and observation with my third participant, repeating this process with each participant in turn. After completing 5 of the 7 initial interviews and observations, I circled back to my first participant, scheduling a second interview. I conducted approximately one interview per month with each participant during the course of the 4-month study. In the times between interviews, I sent participants brief surveys (described more fully in the next section), to

prompt their continued thinking about their informal and incidental learning related to technology integration. I continued in this manner, generating and analyzing data across participants as I went, so that my understanding of the phenomenon was continuously evolving and becoming more nuanced.

As I neared the end of the study and had completed an observation and two or three interviews with most participants, I began to look for signs of data saturation. Looking across the data generated with all participants in my study, I reflected on similarities and differences. In my final interview with each participant, I probed these similarities and differences, allowing the collective experiences of all of the participants to inform my questioning of each participant. My goal was to unearth substantive new ideas that had not emerged during previous interviews. I also used this final interview to ask participants to reflect on the possible impact of their participation in my study on their informal and incidental learning related to technology integration. I was interested in learning about how the study itself might or might not have shaped teachers' thinking about this phenomenon. This step related to the quality of my study, as I will discuss further in the "Quality Criteria" section of this chapter.

Throughout each interview I paused for member checking, asking participants for feedback to clarify their meaning and confirm my understanding of the experiences they shared (Schwandt, 2007). In addition to member checking, Vagle (2014) advises phenomenological researchers to ask follow-up questions during interviews:

> Pay attention to moments in which you assume you know what something means, and then open it up through questioning. This is an incredibly important part of this data-gathering technique. Phenomenologists leave no stone unturned and like

> to study the very things that scholars, practitioners, and fields of study writ large think they (we) have figured out (made definite). Practice using questions to interrogate your own "definiteness." Consider using phrases such as, "tell me more about that," "I have an understanding of that phrase you just used, but can you tell me what it means to you?" (p. 81)

This description is reflective of the type of follow-up questions and prompts I used throughout my interviews with teachers. After each interview, I transcribed the recording. I then compiled a summary of topics discussed to send to each participant for his or her review. This gave participants the opportunity to make clarifications and revisions, as needed, before approving the summary. Occasionally, it also prompted participants to share with me additional insights or experiences related to their informal and incidental learning about technology. Sharing interview summaries and soliciting participant feedback about their accuracy was an additional layer of member checking.

Surveys. In order to elicit participants' written anecdotes, I sent a brief survey (Appendix C) at regularly spaced intervals throughout the study. The survey included a generic prompt ("Please consider which, if any, of the following types of informal or incidental learning related to using technology in the classroom you engaged in during the last two weeks"), followed by several specific examples of informal and incidental learning, such as "talking with a colleague about using technology in the classroom" and "hearing about, discovering, or stumbling onto information that you found useful/helpful/interesting about using technology in the classroom." If participants answered "yes" to any of these specific examples, an additional comment box appeared

prompting them to describe more about what happened. These comments formed the basis for my follow-up interviews with participants.

About 2 weeks after each interview, I sent the survey to participants, asking them to complete it within a 1-week time frame. I wanted to encourage participants to continue thinking about their informal and incidental learning experiences related to technology integration in between our scheduled interviews. These surveys were similar to what Vagle (2014) called "lived experience description[s]" (p. 87). Their purpose was to prompt participants to reflect on and write about specific moments in time when they experienced informal or incidental learning related to technology integration. My goal in provoking participants' reflections was twofold: one, I hoped to gain more insight into the phenomenon of teachers' informal and incidental learning about technology integration; and, two, I hoped that as participants spent more time thinking about and reflecting on their experience of this phenomenon, they would begin to be cognizant of more relevant ideas and connections during our subsequent interviews. In other words, my intention in asking participants to reflect on the ways in which they were learning informally and incidentally was that they would begin to recognize and reflect—independently of my prompting—on more of the ways in which they were learning informally and incidentally.

By alternating surveys with interviews, I continuously prompted my participants to reflect on their informal and incidental learning experiences. In the interview following each survey, I delved more deeply into responses participants gave to the survey items. In this way, I hoped to circumvent the challenges noted by other researchers related to observing informal and incidental learning (e.g., Galanis et al., 2016; Marsick et al.,

2006; Tarc, 2007). I wanted to learn what participants were experiencing, but I also wanted to prompt them to think more frequently and more deeply about their own informal learning.

Observations. I conducted one observation of each participant's classroom. My observation served two purposes. First, it helped me build context for participants' physical surroundings so I could write about them using rich, descriptive detail. This added to the rigor of my results. I discuss rigor in further detail in the "Quality Criteria" section later in this chapter. Second, my observation helped me generate ideas for subsequent interview questions. Recall from the section "The Role of Context" in Chapter 2, that context refers both to the physical space where learning occurs (Putnam & Borko, 2000) and to the implicit assumptions and expectations about learning that are unique to a workplace (Marsick & Watkins, 2001). For this study, participants' experience of their learning contexts—that is, the locations, situations, and circumstances in which their learning takes place—was an essential component to understanding the phenomenon. I conducted observations near the beginning of my data generation process, prior to interviewing each participant. This allowed me to continue to develop a rapport with my participants and also provided me with critical information about the specific types of technologies each participant had access to in the classroom. In this way, I was able to ask specific questions of participants, related to their informal and incidental learning about integrating the observed technologies. For example, if I observed that a participant had a document camera, during our initial interview I asked questions like, "How, if at all, do you use your document camera in the classroom? How did you learn to use it for instruction?"

Initially, I left open the possibility of conducting additional observations of experiences that might be relevant to the phenomenon, such as PLC meetings or professional development sessions related to technology integration. However, none of these supplemental observations proved necessary. Although some participants reported participating in PLC meetings, none reported regular, relevant technology-related learning taking place during those meetings. Since my primary goal in observing participants was to understand, and later write about, their contexts, not to witness their informal and incidental learning, I consider this goal met. Recall from the discussion earlier in this section that many researchers have noted the difficulties in observing informal and incidental learning (e.g., Galanis et al., 2016; Marsick et al., 2006; Tarc, 2007). Thus, my goal was to observe participants' workplace contexts, rather than their informal and incidental learning related to technology integration.

Timeline. The staggered nature of my data generation makes creating a clean, linear timeline problematic. However, I have attempted to help readers visualize the ways in which my data generation activities fit together: initial observation and interview, followed by a survey, followed by another interview, and then another survey, etc. It should be noted, though, that there was substantial overlapping between and among participants as I generated data. For example, the initial interview and observation with one participant was happening, chronologically, alongside the third interview with another participant, at the same time I issued the second survey to two other participants. The reality of generating data with participants who were also full-time classroom teachers meant that I did not expect this to be a straightforward process. My goal was to proceed as logically as possible, while also staying open and flexible.

My analysis of these data—interviews, surveys, and observation notes—was ongoing and recursive. In the next section, I explain more about the recursive nature of phenomenological data analysis and detail the specific methods I used for analyzing the data I generated.

Data Analysis

Phenomenological data analysis is primarily concerned with identifying participants' "significant statements" and then determining common themes revealed by clusters of similar statements (Creswell, 2013). The researcher can then distill those themes into an essential understanding of the phenomenon being studied. One method for phenomenological data analysis Vagle (2014) has recommended is the use of "whole-part-whole analysis methods" (p. 97). Essentially, this involves the researcher reading the available data (e.g., interview transcript or observation notes) in their entirety—this is the first "whole" in the whole-part-whole progression. Next, the researcher conducts a close reading (what Vagle calls a "line-by-line reading" [p. 98]), dividing the whole into meaningful parts and annotating the text with questions and ideas as they emerge. During this "part" analysis, the researcher also writes longer reflections and bracketed ideas into a separate reflexive journal. The reflexive journal is a print or digital journal, maintained by the researcher, and used to document the research process. It includes a complete record of the research process as well as the researcher's thoughts and reflections related to initial data analysis (Lincoln & Guba, 1985).

The first "whole" and "part" readings are conducted with each subsequent text, focusing on one participant at a time. Then, the researcher completes a second and third (and fourth and fifth, if necessary) line-by-line reading, each time identifying segments of

text that might be relevant to the phenomenon. This mirrors the staggered approach to data generation I described in the "Data Generation" section. The final "whole" reading is conducted across participants' data, looking for what Vagle calls "tentative manifestations" (p. 99), or themes, and beginning to form categories or titles for these themes. Vagle repeatedly emphasizes the recursive nature of phenomenological data analysis, noting that such analysis requires the researcher to read, re-read, analyze, and re-analyze throughout the data generation process. The researcher will return to and reflect on, again and again, segments of text that reflect participants' experiences of the phenomenon being studied, constantly analyzing and re-analyzing what it is that makes those segments important.

I compiled interview transcripts, survey responses, and observation notes, and used Dedoose (www.dedoose.com) to keep track of noteworthy statements and emerging themes. Dedoose is a software program that allows researchers to upload written text, like interview transcripts, and then divide the text into meaningful phrases. Those phrases can be labeled with codes or have a short note, called a memo, attached to them. Later, the researcher can search through all of the amassed data, sorting either by participant identity, meaningful phrase, code, or memo. Dedoose allowed me to organize the many texts I generated in my study, and then sort through and codify the texts for reflection and analysis.

Interviews. After conducting initial interviews with each participant, I conducted a preliminary analysis of the data. I uploaded the transcript of each interview into Dedoose, and then I read the transcript, highlighting statements that seemed noteworthy or related to the teacher's informal or incidental learning about technology integration.

Using Dedoose, I then assigned codes or memos to these meaningful excerpts of text. My codes were derived, in part, from the characteristics and examples of informal and incidental learning specified by my theoretical framework. For example, when a teacher shared that she learned about using a particular YouTube video in a reading lesson from a conversation with a colleague, I assigned the codes "informal learning" and "learning from peers or colleagues" to that segment of text. Alternately, when a teacher shared that he learned about a new coding project from an email the product vendor sent, I assigned the codes "incidental learning," "learning from email/Internet," and "learning from a vendor." Many of these terms and classifications came directly from the theory of informal and incidental learning developed by Marsick and Watkins (2001). Others emerged as I began my analysis. Throughout the analysis process, I often encountered excerpts of text that were not easily coded or prompted connections and reflections that did not fit easily into one of the coded categories I had established. In some cases, these excerpts seemed important, but for reasons I could not readily identify. Other times, something one participant shared related to something a different participant had shared. In these instances, I used memos, making notes to myself like: "Separate sessions may not be useful; those who need them most will not attend," or "Follow up on this idea in the next interview."

Once I completed all initial interviews with the teachers in my study, I read through the transcripts again, this time looking for commonalities and emerging themes across all of the teachers' experiences. Keeping with the recursive nature of phenomenological data analysis, I repeated this process at several intervals throughout the data generation process, coding and making memos for individual interviews as well

as comparing interviews from multiple participants to look for emerging similarities and differences. In many cases, I changed codes I had previously assigned or assigned additional codes to existing excerpts. This was especially true with the "context" code—I purposefully bridled my analysis of participants' contexts until later in the data generation process. I wanted to make sure I understood enough about the teachers and their schools to appropriately identify the elements of context in what they shared with me. Just before scheduling final interviews with participants, I reviewed all of the previously generated data for excerpts related to teachers' contexts. I repeated the whole-part-whole reading and coding process with each subsequent round of interviews until no new themes emerged (i.e., data saturation had been reached). Throughout this reading and annotation process, I kept notes in my reflexive journal to bracket my own opinions as they emerged and to keep track of overarching connections that were emerging from the data.

Surveys. I issued surveys to participants about 2 weeks after each interview. I alternated the interview-survey sequence throughout the study. As I collected survey responses from each participant, I uploaded them into Dedoose. I then used the software to code meaningful excerpts of the text from participants' responses, following the same process I described in the previous section. I used memos for longer thoughts and reflections, as well as to plan follow-up questions, to be asked during the next interview with each participant, as described in the "Data Generation" section. Following Vagle's (2014) recommendations, as I neared the end of the study and began to see signs of data saturation, I also read the survey responses across all participants, making note of

commonalities, differences, and emerging themes across participants' responses. This allowed me to plan for the final, reflective interview with each participant.

Observations. After completing each observation, I uploaded my field notes to Dedoose. Then, using Vagle's (2014) whole-part-whole method, I read my field notes from each observation, making notes about anything that seemed important related to the teacher's informal and incidental learning or technology integration. When assigning codes and memos to my observation field notes, I was looking for elements of the teachers' classroom contexts that related to their informal and incidental learning about technology integration. I also made notes about the specific technologies available in each classroom (e.g., "teacher laptop," "student tablets," or "document camera").

Due to the previously discussed difficulties in observing informal and incidental learning, my focus with all observations was to develop my understanding of participants' contexts and to inform my questions for subsequent rounds of interviews. My purpose in analyzing observations was to develop a rich, detailed description of each participant's context. After developing these written descriptions, I looked across all participants' contexts, making note of commonalities, differences, or emerging themes that could inform my subsequent interviews with the participants. I did not analyze observation data with the same recursive depth as my analysis of interview data, but I did refer back to my notes several times throughout the analysis process, and again as I began to write about my findings.

Triangulation. One area where phenomenological data analysis departs from other non-positivistic methods is in a weaker reliance on triangulation. Most qualitative research methods call for researchers to triangulate data—that is, support findings with

multiple pieces of evidence (e.g., interview responses, observations, and document analyses) or multiple participants' experiences. Vagle (2014) has argued that this approach might not always be appropriate for phenomenological research, where "sometimes a single statement, from one participant, at one moment in time is so powerful that it needs to be amplified" (p. 97). Phenomenological analysis methods leave open the possibility that isolated utterances or observations might be essential pieces of understanding the phenomenon. Where possible, I aimed for triangulation, drawing on the multiple participants' perspectives and the multiple types of data that I generated with study participants (i.e., interview transcripts, observation notes, and survey responses). However, consistent with Vagle (2014), I left open the possibility that an isolated utterance or observation might enhance my understanding of the phenomenon of teachers' informal and incidental learning about technology integration. This was, in fact, the case, as readers will see in Chapter 5.

Surfacing results. After a final look across all of the data my participants and I generated, I felt confident data saturation had been reached. In the course of my final interviews with participants, the new ideas that emerged were relatively minor and often echoed ideas expressed by other participants at other points in the study. I spent several weeks reading and re-reading transcripts, memos, and notes from my reflexive journal, as well as adding additional memos and reflexive journal entries. At this stage, the memos and journal entries I made were broader connections, synthesizing experiences across participants. I was beginning to surface tentative conclusions about the phenomenon of these teachers' informal and incidental technology-related learning.

To help me further refine my thinking and surface all of the results of my study, I created a results chart (see excerpt in Appendix D). First, I looked at all of the codes I had assigned to the data in my study. I grouped these codes into similar categories based on their co-occurrence within excerpts of participants' interview transcripts. For example, I noted that "learning from a conference" and "incidental learning" often occurred together, across the participants in my study, so I paired these two codes into a theme group. I then analyzed the ways they fit together, thematically: Why, for example, did participants report learning incidentally, rather than formally or informally, at conferences? In examining the individual excerpts related to participants' conference learning, the answer was that participants often learned about technology incidentally at conferences because the formal learning opportunities offered were a bad fit for their learning needs. Therefore, one theme that surfaced during this process was that "Teachers' learning about technology at conferences is often incidental"; another was "Teachers have unmet learning needs at conferences." I will discuss this example, along with the rest of my results, in greater detail in Chapter 5.

I repeated this process of grouping codes and identifying themes with the rest of the codes I had assigned to excerpts. I then looked across themes for thematic groupings. For example, similar to the process I described in the previous paragraph, one theme that emerged was that, "Teachers' learning about technology from formal presentations is often incidental." When I looked at these two themes together ("Teachers' learning about technology at conferences is often incidental" and "Teachers' learning about technology from formal presentations is often incidental"), questioning what the themes revealed about the phenomenon of teachers' informal and incidental learning related to technology

integration, I could begin to move from theme groupings toward results. As I examined the emergent theme groupings, I repeatedly returned to the central question of my study: "What have these teachers shared with me about their informal and incidental learning related to technology integration?" I tested and revised these emergent themes by comparing each of them to excerpts from several different participants. I kept themes that seemed to fit the experiences of multiple participants, across several contexts and added them to my results chart. I set aside themes that seemed to fit only one participant or context to see if they might be better combined with another theme, rejected altogether, or highlighted as one of the isolated utterances that Vagle (2014) asserted might be essential pieces of understanding the phenomenon. After completing this process with all of the available data my participants and I had generated, I looked across the themes I had added to my results chart and the themes I had set aside. Some of these themes no longer seemed relevant to the central phenomenon I was studying; these I set aside. Others were subsets of or fit within other theme categories I had identified. A few were important isolated utterances that contributed to my understanding of the phenomenon. I present a representation of my results chart in Appendix D and discuss my findings in depth in Chapter 5.

Throughout the design of my study and continuing through data generation, analysis, and the reporting of my findings, I was guided by a pre-planned set of standards for conducting qualitative research. These standards, or quality criteria, helped me produce valid and worthy findings in an ethical manner that followed in the tradition of other respected qualitative researchers.

Quality Criteria

Quality criteria set a standard for what constitutes "high quality qualitative methods" (Tracy, 2010, p. 837). Researchers rely on quality criteria to ensure their methods adhere to high standards and are consistent with the values of a particular research approach. Another benefit of using a pre-determined set of quality criteria is to provide a common language by which other researchers can evaluate a study. The quality criteria I used are Tracy's (2010) "big-tent" criteria for excellent qualitative research. Tracy recommends that researchers first select a *worthy topic*, and then proceed to research the topic with *rich rigor* in generating and analyzing data. Further, researchers should generate and analyze data with *sincerity* and *credibility*, aiming for findings that create *resonance* with readers and make a *significant contribution* to the field of research. Finally, throughout the research process, researchers should strive for *ethical* behaviors and a study that achieves *meaningful coherence*. In the following sections, I will describe each of these criteria in turn.

Worthy topic. Tracy (2010) defines a worthy topic as research that is "relevant, timely, significant, interesting, or evocative" (p. 840). Tracy suggests researchers consider topics that emerge from current events or "question taken-for-granted assumptions" (p. 840), rather than studies based on verifying well established phenomena. As I established in Chapter 2, the topic of teachers' informal and incidental learning about technology integration is certainly timely. The push for teachers to integrate technology in the classroom is not likely to abate anytime soon (e.g., Office of Educational Technology & U.S. Department of Education, 2016). This, coupled with the growth of the educational technology industry attests to the relevance, timeliness, and

significance of studying this phenomenon. Although the final two characteristics on Tracy's list—interesting and evocative—are subjective qualities, her explanation of the types of research that embody those qualities is not. She explains, "studies of little-known phenomena or evocative contexts are intrinsically interesting…people are taken with research that turns common sense assumptions on their head" (p. 841). Although it might be overreaching to say that teachers' informal and incidental learning about technology integration is a little-known phenomenon, it is certainly a less-researched phenomenon than that of teachers' formal learning.

Rich rigor. Rigor refers both to the researcher's diligence in generating data and meticulousness in analyzing the data collected. Tracy (2010) uses the example of an interview, which is of appropriate length, breadth, and detail, along with the interview transcript, which is accurate and scrupulously analyzed. I ensured rigor by conducting multiple rounds of detailed interviews with each participant and by following Vagle's (2014) recommendations for data analysis. Further, as I observed participants, made my field notes, and elicited participants' survey responses and written reflections, I did so with a mind toward data saturation (Corbin & Strauss, 2008), attempting to build as complete a picture of the phenomenon as possible.

Sincerity. Sincerity concerns the researcher's ability to generate and analyze data in a way that is forthright and honest about the researcher's own experiences and vulnerabilities. To ensure the sincerity of my research, I created and maintained a reflexive journal throughout the research process. Further, I completed a Researcher as Instrument statement (Appendix A). This is a formal, written reflection of my own opinions, impressions, experiences, and biases related to teachers' informal and

incidental learning about technology integration, written prior to generating any data. This exercise assisted me in bracketing my pre-existing ideas related to this phenomenon from the lived experiences of the participants in my study. In reporting my research, I have included rich, detailed descriptions of my own research practices as well as a thoughtful reflection of the limitations of my research as they relate to my own limitations as a researcher.

Credibility. Whereas sincerity is mostly concerned with the processes of data generation and analysis, "credibility refers to the trustworthiness, verisimilitude, and plausibility of the research findings" (Tracy, 2010, p. 842). Credible research findings are those that are reported with rich, detailed descriptions of the context surrounding the study, such that readers might draw their own conclusions about the findings' significance. This requires the researcher to study participants and settings closely, looking beyond what is obvious or apparent and into relevant underlying assumptions and values. In part, my observations of teachers in their classrooms contributed to the development of rich, detailed descriptions of their settings.

Credibility also extends into the research process in that results can only be deemed credible if the researcher has taken care to collect multiple forms of data from multiple sources (for the purposes of triangulation) and employed some form of member reflection, such as member checking (for the purposes of generating deeper collaboration and dialogue between participants and researcher). I have already mentioned Vagle's (2014) caution against overreliance on triangulation, but Tracy's (2010) definition of triangulation is compatible with Vagle's stance. She agrees that triangulation is not meant to lead to a singular "truth" about reality and does not hold it up as a necessary condition

for quality research; rather, she views triangulation as the opportunity to dig deeper within the data by examining the same issue or phenomenon from multiple perspectives. As I gathered and analyzed data from interviewing and observing participants as well as collecting their written responses to surveys, I had multiple opportunities to reflect on their experience of the phenomenon at the center of this study. I also conducted member checks three times throughout my study: during interviews themselves, when I confirmed my understanding of participants' responses; after interviews, by sending a summary of the interview transcript for participants to read and correct; and at the conclusion of the study, when I shared my findings with participants and solicited their feedback. Additionally, the participants' final interviews served as a form of reflection and allowed me to verify that data saturation had been reached. I confirmed during these final interviews that I had elicited as many as possible of the important themes related to my research topic.

Resonance. According to Tracy (2010), research achieves resonance when its readers are affected by reading it. Although the researcher's control over how readers are affected is inherently limited, there are steps the researcher can take to increase the likelihood that reported findings have an impact on their intended audience. For example, writing in a way that is engaging and invites readers to view themselves and their experiences through the experiences of the study's participants might lead to a higher degree of resonance. My findings might be considered resonant if readers outside of the teaching profession—perhaps in the fields of counseling or technology education for those outside of the teaching profession—can picture themselves learning in the same informal and incidental ways my participants report learning. In order to increase the

likelihood of this, I have crafted my findings in a voice that invites my readers to make connections to the experiences of my participants. I did this, in part, by describing my participants' contexts in vivid and rich detail, as Vagle (2014) recommended (see Chapter 4). Further, the recommendations I present in Chapter 6 might have resonance for those in positions of organizational or technology leadership in many settings.

Significant contribution. Although there is no way to know in advance the types of contributions my study might make to the current body of research, Tracy outlines four types of significance that researchers can strive for: theoretical, heuristic, practical, and methodological.

Theoretically significant research applies existing theories and concepts to new contexts. I studied teachers' informal and incidental learning related to technology integration (a relatively under-researched phenomenon) in the context of several different school settings. These new contexts included a variety of supports for teachers' learning.

Heuristic significance relates to the impact findings have on readers' desire to learn more about the topic; this is something the researcher has little control over, but heuristic significance can be increased by thoughtful construction of suggestions for future research. Similarly, reporting my findings in a way that is relevant across multiple contexts and arenas (e.g., policymakers, educational leaders, and other professions interested in technology integration) might increase their practical significance.

As Tracy (2010) defines it, *practical significance* is achieved when readers find research useful, either in confronting a current problem or in reframing an idea. I have targeted practical significance by including a section on the implications of my research

findings. This section is written for an audience of fellow researchers, teachers, school leaders, and those who coordinate and deliver professional development for teachers.

It is unlikely that my study can be viewed as having achieved *methodological significance*, as this requires research to break new ground: Tracy (2010) gives the example of studying a problem that has previously only been examined quantitatively through a qualitative lens. My research used well established methods, following in the tradition of earlier phenomenological researchers.

Ethics. There is no one pathway to conducting ethical research. Rather, it relies on a collection of best practices, which Tracy (2010) identifies as "procedural, situational, relational, and exiting ethics" (p. 847). *Procedural ethics* are related to standards mandated by external review boards or funding institutions. I safeguarded procedural ethics by adhering to William & Mary's EDIRC guidelines, including the use of a consent form with all participants (Appendix E), my accurate reporting of findings, and sharing interview summaries with my participants throughout the research process. I have also used pseudonyms for all participants and secured data in a locked file or secure, password-protected digital storage device.

Situational ethics relate to a researcher's constant reevaluation of the research context to reflect on and ensure that ethical research practices are being followed. Tracy (2010) encourages researchers to ask themselves whether the harms of their research practices are overshadowed by the potential of their findings to create good (p. 847). I did this throughout my study, documenting my thought processes in my reflexive journal. Participants signed the informed consent document (Appendix E), affirming their right to cease participation at any time. Further, I believe sharing my findings with my

participants was beneficial to them in affirming and validating their own experiences of informal and incidental learning about technology integration. Finally, I incorporated a question into the final interview to solicit participants' feedback about their participation in my study—6 of the 7 participants shared that participating had been in some way beneficial to them. None reported any negative effects related to participating in my study.

Relational ethics require the researcher to respect participants and share plans, processes, and findings transparently with them throughout the research process. I safeguarded relational ethics by being clear with my participants about the purpose and scope of my research and obtaining their informed consent before generating any data. Also, I shared summaries of my interview notes with them throughout the process, as part of member checking. Since my participants' were practicing teachers, I was especially sensitive to my demands on their time, maintaining a flexible and respectful demeanor when scheduling interviews and observations.

Finally, *exiting ethics* refer to how a researcher treats and presents the stories of participants after data generation has ended. It applies especially to marginalized and underrepresented populations, whose stories might be misused by future readers to further marginalize participants. I shared my findings with participants at the conclusion of my study. I have also taken care to report my findings in ways that respect the unique contributions and experiences of each participant, keeping my focus on the central phenomenon.

Meaningful coherence. Tracy's (2010) final quality criterion is meaningful coherence, or the tendency of research to come together in a rigorous and comprehensive

way. In other words, to achieve meaningful coherence, the researcher must plan extensively prior to generating data. This means choosing a research approach and theoretical framework that not only complement one another, but also clearly flow from the phenomenon the researcher wants to explore. In turn, the approach, framework, and means for generating and analyzing data should flow from evidence in the extant literature related to the phenomenon being investigated. Prior research (i.e., the literature review), the theoretical framework, research method, and reporting of findings must all make sense together in order to achieve meaningful coherence. I achieved meaningful coherence, in part, by sharing Chapters 1-3 with my dissertation committee prior to conducting any research for this study. These chapters represented my plan for research and demonstrated the ways in which my choices logically flowed from both the phenomenon I wished to investigate and the research that has already been done on this phenomenon.

Meaningful coherence requires the researcher to adhere not only to the previously discussed quality criteria, but also to accomplish his or her purpose in conducting research—in my case, to gain a deep and nuanced understanding of the phenomenon of teachers' informal and incidental learning about technology integration. Further, the researcher must meet these goals through the use of established and accepted practices and theories that align with the research approach chosen. I have accomplished both of these goals, adding to the understanding of teachers' informal and incidental technology-related learning, while adhering to the tenets of phenomenological research practices. My selection of Tracy's (2010) quality criteria is another example that demonstrated my commitment to achieving meaningful coherence with my research. Because I selected a

phenomenological research approach, it was appropriate to select quality criteria that support that phenomenology's underlying assumption that there are multiple pathways to and versions of the truth.

Conclusion

As established by the literature presented in Chapter 2, it is safe to assume that teachers learn throughout their careers, along many pathways. Increasingly, this includes learning about technology integration. Although the literature base related to teachers' formal technology-related learning is extensive, what is less understood is how teachers learn informally and incidentally about technology integration. Using the theory of informal and incidental learning developed by Marsick and Watkins (2001), and guided by phenomenological research methods, I studied several teachers' informal and incidental learning experiences related to classroom technology integration. Over the course of several months, I used interviews, surveys, and observations to better understand the phenomenon of these teachers' informal and incidental learning about technology integration. I also examined the impact of the teachers' workplace contexts on their lived experiences, taking into consideration how organizational structures and formal supports influenced these teachers' informal and incidental technology-related learning. In Chapter 4, I introduce readers to the teachers who participated in my study, as well as the building and district contexts in which they worked and learned.

Chapter 4: Participants & Contexts

The purpose of this study was to investigate the phenomenon of teachers' informal and incidental learning related to technology. Recall from Chapter 3 that phenomenological research focuses not on the individual, but on the phenomenon being investigated (Vagle, 2014); in this case, my focus was on the technology-related informal and incidental learning teachers did, more so than on the teachers themselves. However, participants' experiences of their learning contexts—that is, the locations, situations, and circumstances in which their learning takes place—were an essential component to understanding the phenomenon.

Marsick and Watkins (2001) have proposed that workplace context plays an important role in cultivating informal learning. In my study, I included consideration not only of the physical contexts of teachers' learning (e.g., Putnam & Borko, 2000), but also the cultural norms related to professional learning in each unique context (e.g., Webster-Wright, 2009). In this chapter, I provide readers with an overview of the educational contexts in Dogwood Public Schools, the primary setting in which my study's participants worked and learned. Then, I introduce readers to each of the seven participants in my study, providing additional information about each teacher's school, classroom, and educational technology context. Providing vivid descriptions of the participants in my study, as well as the contexts in which they work and learn, might help

readers relate to the experiences my participants shared, contributing to the credibility (Tracy, 2010) of my findings.

School District Context

Dogwood Public Schools is a small, suburban school district located in the Mid-Atlantic region of the United States. The school district has a total enrollment of just over 2,000 students from pre-kindergarten to high school and employ just over 140 teachers. There are four school buildings: a primary school (Grades PreK-2), an elementary school (Grades 3-5), a middle school (Grades 6-8), and a high school (Grades 9-12). The district serves a relatively suburban population, ranging from blue-collar and military families to scientists and engineers who work at nearby technical facilities. The majority of the student population is White. Students in Dogwood Public Schools consistently surpass state averages on the state's standardized tests in English and Math. The surrounding community is passionately involved in the school district—offering both support and criticism. Unlike many school districts in the state, Dogwood Public Schools has a long-serving Superintendent, who is approaching her 10th consecutive year of service in the same position. Dr. Solomon has a clear vision for Dogwood Public Schools and is adept at navigating the small-town politics associated with her position.

In the following sections, I will discuss three unique contextual components of Dogwood Public Schools: their educational technology context, including an arrangement they have with a local business partner; the influence of an educational booster organization, the Dogwood Teaching Innovation Foundation; and the role of their Technology Support Teachers (TSTs) in enhancing teachers' technology-related learning.

Educational technologies. Unique among neighboring school districts, Dogwood Public Schools has entered into an agreement with a local industrial business partner. The school district's IT department provides technical support for both the schools and the business partner. This arrangement provides additional technology funding for schools and personnel, but also creates an additional workload for the IT department. Overall, though, the arrangement has been beneficial. The additional funds provided by the school district's business contract have allowed them to build a more robust technology infrastructure, including fast wireless Internet throughout all schools in the district.

Dogwood Public Schools has been relatively slow to adopt new educational technologies, which has been beneficial in some ways, but also presents unique challenges. One benefit of moving more slowly than neighboring districts is that Dogwood Public Schools has been able to learn from their neighbors' experiences (and mistakes). Observing and deliberating before making purchasing decisions, combined with the small size of the district, means that when the IT department does move forward with implementing a new technology, it happens relatively quickly. Personnel can install and troubleshoot new devices over the course of a few days or weeks, rather than the months and years required in a larger school district.

However, the tendency to move slowly has also caused some teachers to grow impatient and purchase their own educational technologies. Many teachers in the school district have written grant applications to allow them to buy Chromebooks, iPads, and Apple TVs. This, in turn, has led to a scattered collection of technologies that lacks the cohesive implementation and support found in some larger school districts. Although the

district has a strategic plan for educational technologies, it has not been used to guide teachers' individual purchasing decisions.

In general, most classrooms in the district are equipped with a teacher desktop computer; a document camera; an LCD projector and screen or an interactive whiteboard; and access to wireless Internet. Because of the need to complete state standardized tests online, each school also has at least two computer labs with enough desktop computers for a full class of students. Additionally, all schools in the district have class sets of devices like Chromebooks or iPads that teachers can borrow from the Media Center.

Dogwood Teaching Innovation Foundation. Dogwood Public Schools is supported, in part, by a volunteer association called the Dogwood Teaching Innovation Foundation. This group of parents, retired teachers, and community members gives the school district approximately $20,000 each year in the form of grants. Teachers can apply for $300 "instructional innovation grants" to fund experimental or innovative instructional practices, or $1,000 "technology innovation grants" to purchase educational technologies that will support experimental or innovative instructional practices. The technology innovation grants, in particular, have contributed to the diverse assortment of technologies available in various classrooms throughout the district.

Participants in my study frequently referenced the value of the Dogwood Teaching Innovation Foundation in supporting their professional learning. The Foundation is an important feature of the school district's context and enabled teachers in my study to purchase, explore, and learn about new educational technologies that might otherwise have been out of reach, financially.

Technology Support Teachers (TSTs). Dogwood Public Schools employs four full-time TSTs. These TSTs rotate among the four schools in the district, providing technical support as well as co-planning and co-teaching technology-enhanced lessons with teachers. They also respond to work orders and training requests from employees of their local business partner because of the unique arrangement between the schools and the business. Their rotation schedule is somewhat fluid, but most buildings have a TST on campus, for at least part of the day, 5 days per week.

Participants in my study frequently referenced the value of the TSTs in supporting their professional learning. They cited examples of help from the TSTs, including tutorials created and shared online, quick reference tips sent via email, early morning and lunch-and-learn professional development presentations, and assistance with grant-writing. Several participants reported that a TST had encouraged, empowered, or reinforced their technology-related learning. As I will discuss further in Chapter 5, these informal technology mentors offered an important type of formal support for the teachers' informal and incidental learning.

My study included seven participants, who were teachers in Dogwood Public Schools. Celeste, a second-grade teacher, and Brianna, a special education teacher, both taught at Dogwood Primary School. James, a Talented and Gifted (TAG) teacher, taught at Dogwood Elementary School. Susan, a Career and Technical Education (CTE) teacher, taught at Dogwood Middle School. Ashley, a math teacher; Karla, a world languages teacher; and Melissa, a CTE teacher and administrator, taught at Dogwood High School. In the following sections, I provide an overview of each school's context and describe each teacher's classroom context in greater detail.

Dogwood Primary School

Dogwood Primary School has approximately 20 full-time teachers, a principal, and an assistant principal, and serves students in pre-kindergarten through second grade. The building was constructed in the early 1990s, with spacious rooms, large windows, and an expansive Media Center filled with books, student desktop computers, and places students can gather in large and small groups. Teachers at Dogwood Primary School participate in weekly Professional Learning Community (PLC) meetings, weekly grade-level planning meetings, and weekly professional development sessions. The hallways are decorated with student artwork and front office personnel were friendly and welcoming when I visited. The school's atmosphere reflects the close-knit, family-oriented community that surrounds it.

The school has two computer labs with student computers and interactive whiteboards available for whole-class instruction. Dogwood Primary School students also have a mobile laptop computer cart, an iPad cart, and a growing number of Chromebooks teachers can check out in class sets. Nearly all classrooms are equipped with interactive whiteboards and document cameras as well as teacher desktop computers and various digital devices for student use (e.g., iPods, iPads, and student desktop computers). There is a TST in the building 3-4 days each week and the IT personnel are available for troubleshooting technology problems and repairing hardware whenever teachers submit work orders. Two teachers from Dogwood Primary School participated in my study: Celeste, a second-grade teacher, and Brianna, a special education teacher.

Celeste: Second-grade teacher. Celeste has been teaching for over 20 years and considers herself an active user of educational technologies. She is certified to teach pre-

kindergarten through third grade and has both a Bachelor's and Master's degree in Elementary Education. Currently, she teaches second grade. In addition to her job as a teacher, Celeste is a wife and mother; these multiple roles place competing demands on her time. Celeste has close relationships with many of her peers and colleagues. She frequently eats lunch with her fellow teachers, stops by their classrooms before or after school to talk, and exchanges ideas with them in the copy room or hallway. She credited these interactions with much of her technology-related learning, but shared that she also learns from her school's TST as well as the formal professional development sessions offered by the school district.

Classroom context. Celeste's classroom is warm and welcoming, with a large rug where students can join Celeste for whole-group reading instruction or participate in listening stations or independent reading. A large window gives students a view of the playground just outside and provides natural light in the classroom. There are many soft surfaces—rugs and curtains—that contribute to a homey feel and moderate the noise level. There are five large tables for student seating, each with five or six small chairs, sized for second-graders. Each student has a nameplate and pencil holder at his or her seat. There is also a semi-circular teacher table with six student chairs where students can join Celeste for small-group reading and writing instruction. There are two adult chairs, including a rocking chair Celeste sits in to read to her students and to introduce concepts and activities to the class before sending students back to their tables for independent practice. The classroom houses a wall of low, built-in cabinets and several storage towers with drawers, all filled with instructional materials, including curriculum materials, calculators, and gel writing boards for students to use.

Celeste's classroom is well organized. There are several learning stations around the room, including a classroom library and listening station. The classroom library is overflowing with books—there are options for a variety of reading levels and student interests. There are also large stuffed animals students can read aloud to or sit with during independent reading. It is also evident Celeste has well established classroom routines. Students move quickly and amiably between whole-group instruction and independent work, and Celeste has a congenial rapport with her class. Students seem comfortable asking questions of Celeste as well as helping one another with the work they are doing.

Celeste's desk is clean and organized, with detailed lesson plans open on the desk the day I observed. There is a large bookshelf behind her desk filled with print materials related to her teaching—binders with professional development materials, curriculum textbooks, and non-fiction texts related to pedagogy. Celeste later shared that, although she does some of her professional learning in the classroom, much of her lesson planning and research happens at home or in weekly grade-level and PLC meetings.

Available classroom technologies. On the morning I observed, Celeste was using her desktop computer, connected to the classroom interactive whiteboard, to stream music from Pandora. There is a large TV mounted in the corner, but Celeste shared that she rarely uses it since her interactive whiteboard was installed several years ago. Celeste has a document camera, a Chromebook, and an iPad, all of which she reported using daily. At the student listening station, there are five iPods with earbuds attached. Students can use these to choose from a pre-loaded selection of audiobooks, and then read along as they listen. Print copies of the books are in a basket in the listening station and Celeste

shared that she changes the contents of the iPods and the book basket several times each school year.

There is also a station in the room with five desktop computers meant for student use. Each computer has a set of headphones and a poster nearby reminds students of sites they can use when they are at this station: Lexia, Tumblebooks, PebbleGo, and RazKids. Celeste later shared that these are sites she and other teachers frequently recommend to students for both math and literacy practice activities. Students can access these sites at school, in the classroom or Media Center, or at home for additional practice with things like nonfiction reading or solving equations. Celeste also has a personal printer in her room, since she finds it more convenient than the teacher workroom for small print jobs. Celeste shared that she uses most of her classroom technologies on a daily basis and she worries that if one of her tools breaks down, it might not be replaced. Although she is flexible about teaching without technology, she enjoys the conveniences of frequently integrating technology into her instruction.

Brianna: Special education teacher. Brianna is a special education teacher in the same school as Celeste. She has been teaching for over 10 years and is certified in K-12 Special Education as well as Elementary Education. She also holds endorsements to teach students with learning disabilities, intellectual disabilities, and emotional disabilities, as well as to teach early childhood special education. She works with other teachers throughout Dogwood Primary School to provide services for students with disabilities who have Individual Education Programs (IEPs). These students receive specialized instructional modifications and accommodations intended to provide them access to the general curriculum, despite a diagnosed disability. In addition to teaching,

Brianna is a wife, mother, blogger, and part-time student (she graduated shortly before the culmination of my study, earning a Masters in Special Education Inquiry). Like Celeste, Brianna has many demands on her time, but still finds ways to prioritize her own professional learning.

Brianna has frequent occasion to interact with her peers and colleagues throughout the building—perhaps to a greater extent than most other teachers—because she rotates through several teachers' classrooms as part of her regular teaching responsibilities. This means that, unlike Celeste, Brianna's teaching schedule provides her with opportunities to collaborate with teachers across several grade levels. Brianna also learns by teaching others. She is an active member of several online communities related to teaching special education and also blogs about her teaching. Both in the online communities and through her own blog, Brianna shares information with other teachers about teaching special education. Some of this information is related to educational technologies.

Classroom context. Although Celeste and Brianna work in the same small school, their classroom teaching contexts are very different. Much of Brianna's day is spent in other teachers' classrooms, providing special education services to the students on her caseload who are assigned to general education teachers. However, Brianna also provides some "pull-out" services in her own classroom, where small groups of students come to her room for individualized instruction or access to the many assistive technologies that are housed there. Her classroom is also the place where she does much of her professional learning—her desk, desktop computer, and bookshelves are all located in her

classroom. I met Brianna in her classroom during her planning period, when no students were present.

Brianna's classroom is large and bright. There are filters on the standard fluorescent lights that give the classroom a warm, soft glow. Learning stations around the room are designed to encourage learning and play for students as young as 3 who participate in the early childhood program at Dogwood Primary School. There are several large tables with small chairs sized for young students. Brianna also has several bookcases and cabinets filled with manipulatives, learning aids, curriculum materials, and craft supplies. During my visit, she pulled out bin after bin of materials, explaining how each was used to help different types of learners in the classroom.

Evidence of her professional learning and her role as a special education teacher surrounds Brianna's desk. There are print resources, such as textbooks and professional development binders, posted reminders and notes, and printouts of Boardmaker templates she is developing for her students. (Boardmaker is software that allows users to create symbol-based communication grids for students with limited verbal communication skills. Students can point to the symbol or picture associated with the idea they wish to communicate.) Brianna shared that she does much of her professional learning outside of school, in the evenings and weekends, or during her planning period.

Available classroom technologies. Brianna's room is filled with many kinds of technology. Because of her role as a special education teacher, she has myriad assistive technologies designed to help students with disabilities access the general curriculum, like large-print timers and pens that read text aloud for students. Assistive technology is defined as any product, process, strategy, or technique that improves someone's ability to

function or learn ("Assistive Technology," n.d.). Brianna also has a learning station equipped with two student desktop computers with large-type keyboards and a mouse alternative called a switch. The switch allows students with limited fine-motor skills to use the computer by pressing a large button with their whole hand instead of clicking a traditional mouse button with a pointer finger. Each desktop computer also has headphones and headphone splitters that allow students to listen in pairs.

Students in Brianna's class also have access to three iPads and an iPod that she uses for a variety of applications. Brianna has a designated teacher desktop computer equipped with portable external speakers. She has an Apple TV and a Chromebook, which she uses frequently. Brianna recently won a grant from the Dogwood Teaching Innovation Foundation to purchase an assistive reader device for her classroom. At the time I visited, it was still in the box because she had not yet had time to complete an initial setup and orientation with her students.

Celeste and Brianna both reported frequent opportunities to collaborate with and learn from their fellow teachers. Whether in PLC meetings, during lunch, or in grade-level meetings, Dogwood Primary School provided teachers with regular occasions for informal and incidental learning. In contrast, the participant in my study who taught at Dogwood Elementary School had relatively fewer chances to learn with and from his colleagues.

Dogwood Elementary School

Dogwood Elementary School has approximately 30 full-time teachers, a principal, and an assistant principal, and serves students in third through fifth grade. Built in 2010, the school building is the newest in the district—a state-of-the-art, LEED certified

facility, with an outdoor classroom, and an open, modern-industrial feel. Teachers at Dogwood Elementary School participate in weekly PLC meetings, grade-level meetings, and professional development sessions. The numerous windows throughout the hallways and classrooms provide the school with plentiful natural light. Student work decorates the walls and bulletin boards in the main hallways and the building has a warm, welcoming feel. On the morning I visited, students were working on collaborative projects, making use of shared spaces throughout the building.

The principal at Dogwood Elementary School has encouraged teachers to apply for grants through the Dogwood Teaching Innovation Foundation. Many teachers have done so and have directed the funds toward purchasing Chromebooks, iPads, robotics equipment, and other classroom technologies. Because of this, the educational technology context at Dogwood Elementary School is slightly less cohesive than at other schools in the district. There is relatively more exploration on the part of the teachers, who come in contact with a wide variety of educational technologies. Likewise, compared to other schools in the district, there is relatively less focus on making sure every classroom has the same devices. The school shares a TST with Dogwood Middle School, but the TST's office is located at Dogwood Elementary School, so she is frequently in the building and available to teachers. James, the participant in my study who works at Dogwood Elementary School, collaborated frequently with the TST to plan instruction, develop new ways to use his existing classroom technology, and write grant applications for future technology purchases.

James: Talented and Gifted (TAG) teacher. James has been teaching for over 15 years, mostly in his current position. He is certified in reading and math and holds an

endorsement for gifted education. Currently, he teaches fourth- and fifth-grade students in both gifted reading and gifted math. He described his job as "the best job in the district" and is very fulfilled by his work. James is an avid technology user, and is constantly seeking out new tools, especially in the fields of coding and robotics, to introduce in the classroom. In contrast to Celeste and Brianna, James feels slightly disconnected from his fellow teachers. He is the only TAG teacher for his grade level and content areas. He is also the only classroom teacher in the school who is enthusiastically implementing coding and robotics into the reading and math curriculum. Because of his teaching schedule, he is unable to participate in weekly grade-level meetings, PLC meetings, and professional development sessions with his peers and colleagues.

After his teaching day ends, James has responsibilities as a coach, husband, and father, so he often finds his professional learning time limited to what he can fit in during the school day. Because James teaches slightly older students than Celeste and Brianna, he has comparatively more freedom to make time for his own professional learning during the school day; he has methodically and deliberately structured his classroom routines to fit in more time for his own professional learning. This learning often happens while students are engaged in independent work, but James also learns with and alongside his students through trial-and-error. He likes learning from watching videos, either on YouTube or, sometimes, on vendors' websites. James works closely with the building's TST to develop his coding and robotics programs. They often collaborate and learn together; over the course of the study, they were actively involved in expanding the robotics curriculum through funding awarded to them by the Dogwood Teaching Innovation Foundation.

Classroom context. James' large, oblong classroom was filled with natural light from a wall of windows along the back of the room. Even early in the school year (I observed James less than a month after school had started), James had an easy rapport with his students, circulating among them and gently redirecting or asking guiding questions. There is a pleasant sense of clutter—it is obvious that students are actively involved in a variety of activities throughout the day, from computer-based assignments, to small reading groups, to puzzles and other hands-on activities. It is also obvious that James had structured his classroom space with students in mind. Students easily and independently navigate the room to retrieve materials they need and to collaborate with one another on their latest coding project. Along one wall of James' classroom, an expanse of windows provides a view of the school's outdoor classroom.

Student work is displayed around the room, as are folders with additional activities for students to select and work on independently. James shared with me that he values student-centered and student-directed learning, and these activities are meant to support those types of learning. In addition to a wall of built-in cabinets, there are several bookshelves around the room, filled with novels for student-choice reading, as well as several types of textbooks. Student desks are grouped in clusters and there are large tables as well for small-group work. Although students have assigned seats, James shared that they frequently rearrange themselves based on the day's activities or their own learning needs. James' desk is covered with instructional materials and the bookcase behind his desk is overflowing with additional curriculum resources, professional development binders, and books related to teaching gifted learners. To a greater extent than in Celeste and Brianna's room, James' desk feels integrated into the classroom;

students are free to approach his desk with questions or to show him what they are working on.

Available classroom technologies. On the morning I observed James' class, his 15 students were working independently on a drag-and-drop coding activity using Tynker. Each student worked on Chromebooks from a class set borrowed from the Media Center or one of the five desktop computers in the classroom. Like Celeste and Brianna, James has a document camera, an LCD projector and screen, and external speakers attached to his teacher desktop computer. His desktop computer is located on his desk, surrounded by the print reference materials he uses in planning instruction and his own professional learning.

During my visit, he showed me an Arduino kit he had just opened and started to explore. The Arduino kit is a system of circuits and lights, controlled by a small, simple computer, that students can build, modify, and program in a variety of ways to accomplish different tasks. James later shared that the elementary school's TST dropped the kit off with him one day and told him to explore it. He was excited to do so. James also showed me one of several simple robots his students program using Tynker, an online coding program. James shared that he is constantly searching for new technology to share with his students, including new ways to use the robotics and coding tools he already has on hand. Tynker is one example of this; he introduced students to the site shortly after learning about it himself.

Both Dogwood Primary School and Dogwood Elementary school provided formal supports for teachers' professional learning in the form of PLC and grade-level meetings. However, James's unique teaching schedule precluded him from capitalizing on those

supports. Yet, he shared examples of benefiting from a workplace culture that valued collaboration and collegiality. In contrast, Dogwood Middle School does not provide these types of formal supports. Susan, the teacher in my study from Dogwood Middle School experienced some of the same feelings of isolation that James shared, but with comparatively fewer opportunities to learn with and from her colleagues than James had.

Dogwood Middle School

Dogwood Middle School has about 35 full-time teachers, a principal, and an assistant principal. The building, which is nearly 100 years old, is the oldest in the district. Teachers at Dogwood Middle School participate in monthly department meetings and monthly faculty meetings. In contrast to the primary school and the elementary school, there are no formally established PLCs at the middle school. Also in contrast to the primary school and elementary school, the middle school has experienced relatively more turnover in staffing. During the course of my study, teachers were adjusting to a new principal and assistant principal. Past administrators have struggled with winning staff buy-in for new initiatives and it remains to be seen if this trend will continue. The hallways at Dogwood Middle School are used to display student work; athletic awards, trophies, and pennants; and a gallery wall of photos showing Citizens of the Month.

It is clear that, despite the age of the building, it is well cared for. Floors are freshly waxed and walls have been recently painted. However, the realties of working in an older building sometimes present a challenge for teachers trying to incorporate new technology in the classroom. For example, rooms designated as computer labs are smaller and harder to navigate than similar spaces at the primary and elementary schools. Further, the building was not designed with adequate electrical outlets for the many digital

devices teachers are integrating into instruction. Teachers have adapted to this by using power strips, extension cords, and, in some cases, submitting work orders for the IT department to install new outlets. Recall that Dogwood Middle School shares a TST with Dogwood Elementary School, so the TST is not always in the building. However, she offers before-school technology professional development several times a month. Susan, the teacher in my study who works at Dogwood Middle School, shared that she feels very supported by the school district's IT department, including the TST assigned to her school.

Susan: Career and Technical Education (CTE) teacher. Susan is a veteran educator, with over 30 years of teaching experience. Currently, she teaches middle school students from Grades 6-8 and also sponsors the school newspaper. Like James, Susan sometimes feels somewhat isolated from her colleagues—she is the only CTE teacher at the middle school. Also like James, she collaborates frequently with the TST assigned to the middle school. She also works with the CTE department chairperson, who teaches primarily at the high school. Susan's children are adults, so compared to Celeste, Brianna, and James, she has relatively more time to focus on her own interests, hobbies, and professional learning. However, she still sometimes struggles to balance competing demands on her time—between planning instruction, grading papers, and keeping up with her other teaching responsibilities, her own learning is not always her top priority.

Susan learns about technology in many informal and incidental ways. She often learns from her two adult sons, who share technology ideas they have found online, and she is an avid conference participant. Susan does most of her professional learning after school, "when the kids are gone and it's finally quiet," and during summer break. Like

James, Susan enjoys learning from videos. She is also a member of several professional organizations and learns from the newsletters the organizations send. She finds that many learning tasks in her content area are better suited to being physically present in her classroom. For example, throughout the course of the study, Susan was troubleshooting problems with her new 3-D printer. However, she was limited by not being able to take the printer home; it was simply too big to be easily transported between her home and her classroom.

Classroom context. In contrast to Celeste, Brianna, and James, Susan has a non-traditional classroom space. On the afternoon I observed, there were no students present, so Susan was able to give me an extensive tour. The main classroom area is arranged as a computer lab, with student desktop computers on long tables facing the front of the room. Similar to James's classroom, Susan's has a student-centered feel—materials are easily accessible to students and it is clear she has put thought into arranging the space in a way that will be comfortable for her students. Despite the many computers and chairs, there is still space to move around the classroom. There are several large closets that store the many instructional materials required for Susan's curriculum.

In a connected space, Susan has a CTE workshop—a large open space, with concrete floors, that is filled with tools, student projects, large workbenches, and all of the technical equipment required for her curriculum. The workshop side of her space is also filled with several large lockers to keep materials and equipment organized when they are not in use. In the workshop, Susan has a band saw, a small wind tunnel, machines for bending plastic and metal, and other specialized tools. Also in this space, there are large standing-height tables with stools for students to collaborate on projects.

Stepping through the door from the main classroom, it is clear that a different kind of work happens here. Susan later shared that students often progress from planning projects in the main classroom to actually building and testing them in the workshop space.

Available classroom technologies. Susan's expansive classroom is overflowing with educational technologies—a full set of student desktop computers; two 3-D printers; a document camera; a projector; surround-sound speakers; color and black-and-white printers; and countless hands-on resources for students to learn about circuits, solar power, drag and lift, and other concepts related to the CTE curriculum. It is clear this room has been retrofitted to house computers. The building was not originally designed to accommodate the many devices that are plugged in throughout the space and columns have been added throughout the room to provide outlets in close proximity to devices.

Susan shared that a key element of her teaching is a suite of software the department recently purchased. It allows students to learn computer-aided drafting techniques and to design plans for bridges and racecars. The students can then take their designs into the workshop and build what they have planned. Susan shared that students enjoy testing their bridges and racecars against one another. They also enjoy the flight simulator software she uses to teach them about drag and lift; since adding this unit to her curriculum, elective enrollment in her courses has increased. Technology is so thoroughly integrated into Susan's CTE curriculum that few elements of her teaching are untouched by some type of technology.

Dogwood Primary, Elementary, and Middle Schools share similar educational technology contexts: many technologies, like document cameras and LCD projectors, are nearly uniform in their availability, and almost every classroom has both. Other

technologies, like Boogie Boards at the primary school, robots at the elementary school, and flight-simulation software at the middle school, are differentiated, and only a handful of teachers have access to them. In contrast, Dogwood High School has relatively more differentiation of educational technologies. In part, this is because the larger school, higher number of teachers, and greater variety of course offerings naturally lends itself to more variety in available technologies. However, the varied assortment of technologies is also related to the high school's piloting of a Bring Your Own Device (BYOD) initiative that allows each student to bring personal digital devices, like tablets, e-readers, or smart phones to school each day.

Dogwood High School

Dogwood High School has nearly 60 full-time teachers, a principal, and two assistant principals. Built in the late 1970s, the high school is the second oldest facility in the district. Similar to Dogwood Middle School, teachers at the high school attend monthly department and faculty meetings. Most professional development opportunities are offered on a voluntary basis and there are no formally scheduled PLC meetings. Many teachers do have common planning periods or lunch times with other teachers from their departments. Participants in my study from Dogwood High School shared that, with respect to professional learning, teachers at the school tend to keep to themselves or collaborate within departments. Lunchtime conversations tend to revolve around current events or social concerns rather than instruction. Additionally, the many veteran staff members are sometimes resistant to change, which has occasionally frustrated building administrators and younger staff members.

Teachers in the high school struggle with some of the same facilities limitations as teachers at the middle school: sometimes there are not enough outlets to power the many digital devices they wish to use. However, the IT department has had a somewhat easier time retrofitting rooms at the high school than the middle school. In contrast to the elementary school, the high school has a somewhat more cohesive classroom technology plan: nearly every room has a projector or interactive whiteboard, a document camera, and a teacher desktop computer. However, not all teachers have the same brand of interactive whiteboard or document camera, which can sometimes inhibit teachers' ability to help one another troubleshoot the devices. There are several computer labs and teachers may borrow class sets of laptops, Chromebooks, or iPads from the Media Center.

Unique in the district, Dogwood High School is in the second year of a BYOD pilot program. Although many teachers enjoy the flexibility offered by the BYOD program, it is clear the school has not yet fully embraced the initiative. Flyers in the cafeteria advertising BYOD are posted next to signs that say "No Cell Phone Zone." Individual teachers (including one of the participants in my study) have similar policies in their own classrooms. Dogwood High School shares two TSTs with other schools in the district; one TST is available 4 days per week and the other is available only 1 day per week. Three teachers from Dogwood High School participated in my study: Karla, a world languages teacher; Ashley, a mathematics teacher; and Melissa, a CTE teacher and administrator.

Karla: World languages teacher. Karla is unique among the participants in my study because she completed her initial teacher training and first years of teaching in

Europe. As an immigrant to the United States, she has a distinctive perspective and voice related to teaching, teacher preparation, and professional learning. Karla is a veteran teacher, with over 30 years of experience. She is certified to teach middle and high school world language in German, French, Spanish, Russian, and English. She is fluent in all of these languages and currently teaches mixed grade-level classes in two different languages.

Although Karla volunteered to participate in my study when she heard about it from her principal, she professed that she "tends to be critical of technology" and feels frustrated by her students and colleagues who tend to look at their screens instead of talking with one another. This frustration has led her to eat lunch outside, with a likeminded colleague in the same department. Karla vacillates between avoiding professional learning related to technology and finding ways to integrate technology in ways that are compatible with her teaching style and students' interests. For example, when she learned—incidentally—about an online review game, she immediately saw its potential for her classroom. After a student-teacher mentioned the game, Karla's interest was piqued and she wanted to learn more; Karla's learning became intentional, continuing along informal pathways. The student-teacher gave Karla a short, face-to-face tutorial about using the game. Karla quickly mastered it, uses it frequently, and has even presented her experience with the game at a conference.

However, she also feels frustrated by the many barriers to her technology-related learning: the high school's TST is overworked and not always available when Karla has a question, the school's firewall prevents her from accessing online review materials she thinks would be useful to her students, and professional development offerings are not

always suited to her learning style. Karla prefers to learn face-to-face, with chances to explore new technology hands-on, but with the support of a TST or other informal technology mentor. Karla also learns about technology from family members, like her adult son, and from her students. She shared that she does most of her professional learning at home. She has a strong preference for using her personal laptop rather than the teacher desktop provided by the school district. She shared that it was part of her training in Europe to do most of her preparation outside of the classroom; she often devotes several hours over the weekend to planning lessons and organizing resources for the week ahead.

Classroom context. Karla's classroom reflects her devotion to her content-area. Unlike the bright, homey feel of Celeste's primary school classroom or the industrial lab setting of Susan's classroom-workshop, Karla's is a more typical high school classroom. The large, mostly square room has no windows. Desks are aligned in rows facing a screen and whiteboard at the front of the room. There are many posters on the walls depicting European countries, with large headlines in Spanish, German, or Italian. There is also space to display student work.

On the morning I observed, Karla had a relaxed, easygoing rapport with her students. Like James, she interacted warmly with her students, moving seamlessly between balancing the business of learning and catching up on current events in her students' lives, with a light, joking tone. Unlike James, Karla relies on a filing cabinet to store and organize paper handouts for class assignments. Karla's desk, as well as a nearby bookshelf, was covered with stacks of papers and textbooks related to her curriculum.

Available classroom technologies. Karla has relatively little technology in her classroom. Like the other teachers in my study, she has a document camera, but she shared that she does not use it often. Despite the school's BYOD initiative, she also has a sign in her classroom declaring "No Cell Phones." She later shared with me that this stems from her frustration with students spending too much time staring at their phones and not enough time engaging with one another. Occasionally, she does plan activities that allow for students to use their personal devices and has recently started using an app a student shared with her that allows her to send reminders to her classes about upcoming tests and quizzes.

The day I observed, Karla was using her LCD projector to display a review activity on the screen at the front of the classroom. She also has access to a teacher desktop computer, but strongly prefers to use her personal laptop. She shared that this practice has sometimes been a source of frustration since file formats are not always compatible between her personal MacBook and the school-issued PC. Further, her tendency to prepare lessons at home sometimes leads to difficulty accessing websites that she later discovers blocked by the school district's Internet firewall.

Ashley: Mathematics teacher. Like Karla, Ashley teaches mixed-grade level courses. She has been teaching for 4 years, and is relatively new to Dogwood High School. She previously taught in another school in her home state and, in interviews, frequently reflected on the differences in the two teaching contexts. Ashley is certified to teach high school math and holds both a Bachelor's and a Master's in Secondary Math Education.

Ashley considers herself to be tech-savvy, both as a teacher and in her personal life. She does much of her learning outside of the classroom, especially during the summer and winter breaks. She shared that she often sets professional learning goals for the summer and often reflects on how she can improve her teaching. In some ways, she is frustrated with the culture of Dogwood High School, where the many veteran teachers are sometimes reluctant to change and try new methods, including technology-enhanced teaching. In her previous job, she was encouraged and supported by her peers and colleagues in implementing technology into instruction. Now, she sometimes resists incorporating technology because she is not always certain her students are ready.

In addition to teaching, Ashley is also the sponsor of the senior class, coordinating fundraising efforts to benefit senior-class activities. Because of her extracurricular involvement, as well as the math tutoring she often does after school, there are many demands on Ashley's time. Like Celeste, Brianna, and James, Ashley often finds herself short on time. She shared that her own professional learning is often sacrificed in order to make more time for helping students and grading papers.

Classroom context. Ashley's classroom is similar to Karla's in that it is a large, square room, with no window. However, unlike the rows in Karla's room, Ashley has arranged students' desks into groups of three. There is still ample space for her to move between and among the groups, and on the morning I observed she circulated among the students as they worked on a test review. In some of Ashley's general education classes, special education students are mainstreamed in the classroom. This means students with IEPs receive instruction alongside their general education peers. In the class I observed, there was a special education co-teacher present, but Ashley was responsible for whole

group instruction. There is little clutter in the room and the bookshelves and cabinets are filled with instructional and reference materials—math textbooks, bins of calculators, and user manuals for the graphing calculators her students use.

Ashley's desk is clean and well organized, with a tray to sort papers associated with the different classes she teaches. Behind her desk, she has a bulletin board of personal photos. She has a microwave and mini-refrigerator in her room and there are content-area and motivational posters on the walls, contributing to a homey feel. Similar to James's classroom and Susan's workshop, Ashley's shows evidence of student-centered learning. On one bulletin board, there are student-generated posters listing the traits of a successful math student. The markers for the whiteboard are readily available for student use, so that students can practice solving equations at the board, either independently or with Ashley's help.

Available classroom technologies. Ashley's has relatively more available technology than Karla. She has an interactive whiteboard, a document camera (that she uses "every day"), and a teacher desktop computer. Like Karla, Ashley also has a personal MacBook; she prefers using Mac to PC and was accustomed to preparing lessons on a Mac in her previous school setting. In contrast to Karla's "No Cell Phones" sign, Ashley has posted a reminder for seniors to sign up for text alerts related to senior class activities. Ashley's students are encouraged to use their personal devices to access the class website or view online tutorials that might help them review for the upcoming test. Like James, Ashley also has calculators available for student use.

On the morning I observed, Ashley was still acclimating to her relatively new interactive whiteboard. This required her to complete a quick calibration during class.

Behind the scenes, Ashley is also an avid user of educational technologies—she shared that her class website is an important tool in supporting students' learning. She also shared that, because she uses her website differently than many of the other teachers at Dogwood High School, she has had to teach her students what to expect. Whereas many teachers at the high school use their websites for general class information, like sharing the syllabus and required materials, Ashley frequently updates her site with review information, links to additional math resources, and reminders about upcoming deadlines for students.

Melissa: CTE teacher and administrator. Like Susan, Melissa is a CTE teacher. She has been teaching for more than 15 years and, in addition to her CTE certification, is also endorsed as a technology educator. Like James and Ashley, Melissa is committed to student-centered learning. Melissa considers herself to be tech-savvy and reported that she frequently helps her peers and colleagues with integrating technology. She does have a few informal technology mentors who she learns with and from, including the school's TST. Melissa shared from the first interview that the majority of her technology-related learning is informal or incidental. She attributed her tendency to learn through informal avenues to the lack of professional learning opportunities in the school district—she shared that she often finds these opportunities do not meet her learning needs.

In addition to teaching, Melissa is a school administrator, serving as an instructional specialist at the School Board Office. She also sponsors a STEM club at the middle school and has a young daughter who attends the elementary school. Her many roles place competing demands on her time and, like all of the other participants in my

study, she finds herself fitting in professional learning when and where she can. Often, her own professional learning is a lower priority than fulfilling her other responsibilities as a teacher, club-sponsor, administrator, and mother.

Classroom context. Despite teaching in the same building as Karla and Ashley, as a function of her content-area, Melissa's classroom looks quite different from Karla's and Ashley's. It is more similar to Susan's classroom, although still uniquely adapted to both the high school setting and the specific content areas Melissa teaches. The main classroom area is set up as a computer lab, filled with student desktop computers. However, like Susan, Melissa has an additional workshop area. The walls of the main classroom are covered with large-scale printouts of students' work—mostly computer-aided drafting designs that students have entered into design contests. At the front of the room, accessible to students, there are trays of drafting materials, like rulers and a lightbox for tracing designs. Melissa shared that she has many additional professional learning resources in her office, which I did not visit.

Melissa's desk is tidy and organized, with evidence of many professional resources on the built-in shelf. There are content-area DVDs, print materials related to her curriculum, and small baskets of hand-drafting materials, which students have free access to. Like James and Ashley, Melissa encourages students to work independently. She has an easy, professional rapport with her students. During my observation, she was giving them feedback about their latest projects in a manner that she shared was similar to what they will find in the workplace. On the morning I observed, students were comfortable approaching Melissa's desk to ask questions and get help with their assignments.

Available classroom technologies. Like Susan, many of Melissa's classroom technologies are specific to her content area. However, she also has a projector and screen, a document camera, and a teacher desktop computer, like the other participants in my study. Like Celeste, Melissa has a personal printer in her classroom, which students have free access to. Melissa also has two 3-D printers: a small, portable version and a larger one housed in the attached workshop. The larger printer is relatively new and has required extensive troubleshooting, including conversations with the vendor who sold Melissa the device.

On the morning I observed, students were working through a self-paced module introducing the next unit of study. Melissa shared that she had worked with the school's TST to develop several modules, which include embedded videos and opportunities for students to practice new skills independently. Melissa maintains shared digital folders with each of her students, allowing her to collaborate with them, virtually and during class, to refine their computer-based assignments. Like Susan, technology is so thoroughly integrated into Melissa's CTE curriculum that few elements of her teaching are untouched by some type of technology.

Conclusion

Celeste, Brianna, James, Susan, Karla, Ashley, and Melissa each have many unique experiences related to learning informally and incidentally about classroom technology. Similarly, their unique teaching contexts and content areas influenced their learning related to classroom technologies. Yet, despite their many differences—in age, years of teaching experience, educational background, and outside interests—the teachers

who participated in my study were all actively engaged in integrating technology into their instruction, at least to some extent.

They were also universally involved in learning about educational technologies, often through informal and incidental pathways. In Chapter 5, I will look across these teachers' lived experiences to explore more deeply the phenomenon of informal and incidental learning related to technology. I will draw heavily on the teachers' individual experiences and reflections, but with the goal of surveying the common ground across their experiences. In this way, I hope to define more clearly the phenomenon of teachers' informal and incidental learning related to technology integration.

Chapter 5: Results

In Chapter 4, I introduced readers to the seven teachers who participated in my study as well as their classroom contexts, available educational technologies, and the larger context of the school district in which they worked, Dogwood Public Schools. In this chapter, I present what these teachers shared with me, related to their informal and incidental technology-learning experiences. Recall from Chapter 2 that professional learning is a continuous process, not associated with any one distinct event or activity (Webster-Wright, 2009). Further recall that research related to teachers' technology professional learning has historically focused on formal learning opportunities, also known as technology professional development. In contrast, my research focused on the ways teachers learned about integrating technology informally and incidentally. As a reminder, incidental learning refers to unplanned, spontaneous learning; informal learning refers to planned or purposeful learning that occurs along unstructured pathways (Marsick & Watkins, 2001). For example, when a teacher stumbles across an advertisement for a new classroom technology and realizes it could be useful in the classroom, incidental learning has occurred. But when the teacher then goes online to research the technology and watch a YouTube video of another teacher demonstrating the technology, learning has become informal. I investigated the phenomenon of teachers' informal and incidental learning related to technology integration through observations, interviews, and surveys. In this chapter, I discuss my findings, presenting specific

examples of the different types of informal and incidental learning teachers in my study reported, and continuing with an analysis of what their collective experiences revealed about this phenomenon.

Teacher Learning Along Many Pathways

Teachers' learning about technology integration happens along many pathways. These *learning pathways*, which emerged from my analysis of the data generated in this study, were alternately and concurrently formal, informal, or incidental; involved many types of media or approaches to learning; and changed depending on teachers' learning needs, preferences, and the technology being learned. In short, teachers took many routes, or learning pathways, in the course of learning about new technologies or new uses for existing technologies. My research focused on the technology-related learning that happened along informal and incidental pathways. Across the experiences of the participants in my study, the idea of learning along many pathways came up repeatedly. A typical example of this is illustrated with something Susan, the middle school Career and Technical Education (CTE) teacher, shared: "Usually it starts out at a conference and that's what tweaks me. Occasionally I'll get a flyer or a magazine or even an email. And then from there I'll explore and see what they're offering." In other words, when Susan learned about a new technology from a vendor or a colleague at a conference, or from print or digital texts, this incidental learning experience piqued her interest. Then, if the technology seemed applicable to her curriculum or her students' learning needs, Susan followed up on the learning through other pathways, both formal and informal. She talked with other CTE colleagues at the conference or sought out more information from professional journals or online research. Her learning became intentional. Undergirding

Susan's learning, the hidden influence of formal supports was also at play—her school district paid for her to attend the conference, which became the foundation for her technology-related learning.

Many other participants reported similar experiences to Susan's. Celeste, the primary school teacher, stated succinctly that her technology-related learning was often "a good combination of formal, informal, and incidental." Similarly, Brianna, the special education teacher, shared, "I'm the type of person who can look at it and watch the video, but then I also need to read about it. The videos aren't enough for me." And James, the elementary school TAG teacher, explained that his interest in robotics started with an incidental encounter and evolved into his development of new curricula for his students: "I read about it; it looked really, really neat. I watched the videos, looked at the website, emailed the company, got some ideas of how you can get started with something like that." In each of these examples, across grade levels, content areas, and learning preferences, the teachers in my study learned about integrating technology along a variety of pathways.

Importantly, other than the role of learning preferences (which I will discuss further later in this chapter), the teachers did not seem to value any one type of learning above the others. In other words, they appreciated their informal and incidental learning experiences equally to their formal learning experiences. Although they often shared that formal professional development sessions left them with unmet learning needs, they seemed to accept this as inherent to the nature of formal learning. For most of the teachers in my study, they expected to continue their technology-related learning along informal pathways, even after participating in high quality formal learning activities. This

suggests that teachers' informal and incidental learning about technology integration might have a previously neglected or overlooked value that school districts should heed.

An examination of literature related to teachers' self-directed learning with technology revealed that other researchers have noted similar findings. Hiltz (2015) compared teachers' technology knowledge acquisition when they participated in self-directed versus facilitated technology-related learning sessions. She found that teachers had positive opinions of both types of learning, and chose a learning format based on many factors, including their own prior knowledge and the limitations of time—both themes that surfaced with participants in my study as well. Hiltz (2015) concluded that providing teachers multiple pathways to learning technology might be the best approach. Similarly, W. M. Jones and Dexter (2016) have proposed combining formal and informal modes of teacher learning, encouraging schools to leverage the power of "organizational supports" (similar to the *formal supports* I discuss elsewhere in this chapter) to extend and enhance teachers' learning about technology integration. The teachers in my study learned about technology along many pathways and often relied on formal, organizational supports to extend their learning. In the following sections, I explore each of these individual pathways in greater detail and specificity, looking at the ways teachers in my study learned about technology through trial-and-error, by exploring independently, and from talking with peers and colleagues. Then, I examine the ways in which these pathways interacted and overlapped as teachers learned about integrating technology.

Trial-and-Error: "Just roll it out in the classroom and see what happens"

When I asked the teachers in my study how often they learned about integrating technology through trial-and-error, the most common response was laughter. This was

followed by remarks like "all the time" and "we do a lot of that" and "90% of the time." It is important here to make a distinction between *trial-and-error learning* and *exploratory learning*. For the purposes of my research, I categorized trial-and-error learning as learning that happened with students present. In other words, when teachers shared examples of taking a new technology (or an existing technology, used in a new way) and introducing it to students with little prior rehearsal, experimentation, or practice, I considered this learning through trial-and-error. When teachers explored a new technology (or an existing technology, used in a new way) independently, for the purposes of learning, I categorized this as exploratory learning. I will discuss the important role of exploratory learning in a later section. Learning about technology through trial-and-error was an important avenue for teachers' informal and incidental learning about technology.

Most of the participants in my study provided examples of learning about technology through trial-and-error. They said things similar to Brianna, who shared, "I'll just roll it out in the classroom and see what happens….I just kind of [throw] it out there with no real plan." Recall from Chapter 4 that Brianna is a special education teacher who works with students as young as pre-kindergarten. Yet she, like the other teachers in my study, was successful with this method of technology-related learning. Her experience suggests that trial-and-error learning need not be limited to teachers of older students.

However, learning through trial-and-error was something teachers in my study considered precarious. Celeste, the primary school teacher, described the inherent risk of learning in this way:

> It could be perfect for you and when you get it into a classroom of 21 children, it totally does not work the way you intended or thought it would work. I think there's a lot of trial-and-error until you get it right and then you go with what went right.

Similarly, Ashley, the high school math teacher, shared the example of using new math software to have students review for a test:

> It was really kind of an experiment for me to see how it works and how it could typically go in the classroom…if it's better as an in-class tool or an at-home tool, if it's good for both. It was a little nerve-wracking for me, but I told the kids, "This is my first time using this; here's what I want you to do."

And although these classroom experiments usually turned out well for the teachers, there were times when this type of learning was not as successful. James, the elementary school TAG teacher, shared an example of students learning to use a new wiring kit: "There weren't very many instructions, which is how we blew up the light bulb, because I didn't see anything to tell me what things meant." Despite this misstep, James planned to continue learning through trial-and-error, in part because he felt this type of learning was beneficial for his students. He reflected that it was good for them to see that even teachers make mistakes and have to find new ways to solve problems. And, on a practical level, he often found that it was hard to stay far enough ahead of his students to map out their learning activities in advance. For James, trial-and-error learning was a necessity.

In contrast to the experiences of Brianna, Celeste, Ashley, and James, for one of the teachers in my study, trial-and-error learning was an exercise in frustration. Although Karla, the high school world languages teacher, reported attempting to learn through trial-

and-error, she shared, "usually I think there are more errors than successes….I will try a few things—'Oh maybe if I do this'—And usually I don't get very far that way because I am so inept." For Karla, and possibly for teachers like her who feel a steep learning curve related to integrating technology, the low likelihood of success through trial-and-error learning makes this a less fitting pathway. Karla's experience highlighted an important limitation of teachers' informal and incidental learning that I will explore further in Chapter 6.

Exploring: "Just to play around and see what I can do"

Closely related to learning through trial-and-error, all of the teachers in my study reported learning about technology through exploration or, in their words, "just clicking on things." For some of the teachers in my study, this exploration included watching videos about technology or reading printed texts related to technology. When I asked teachers about their exploratory learning, two teachers said they did "90%" of their technology-related learning this way; one said "60-70%" of her technology-related learning was exploratory in nature. An example of a teacher's exploratory learning happened when James, the elementary school TAG teacher, first received an Arduino kit from an informal technology mentor. An Arduino kit is a small, simple computer paired with a set of circuits. Users can program the computer to respond to basic commands, like pushing a button to turn on a light bulb. When James received the Arduino kit, he knew nothing about it. But he "just started playing around" until he figured out enough about the kit to introduce it to students. However, as James later discovered, his exploratory learning did not prepare him for all of the ways his students would want to use the kit—and "that's how we blew up the light bulb." Although James's learning

began as informal, exploratory learning, it continued through trial-and-error, learning alongside his students.

Oftentimes, for the teachers in my study, exploratory learning was a function of necessity. For example, Celeste, the primary school teacher, shared,

> When we got our projectors, they put them in our rooms and then they were done. How do you work it? I didn't even know how to turn it on! I was interested; I wanted to use it. So, I turned it on and started playing. A lot of times that's what happens. Because there's not enough time for professional development. There's not enough time to let us know how to do things.

Celeste identified a lack of time for formal professional development as a reason for learning informally, through exploration. Recall from Chapter 2 that many school districts struggle to implement high quality, ongoing programs of formal professional development (Garet et al., 2001), so Celeste's experience might be relatively common. In a related example, Celeste shared an anecdote about teachers receiving new iPads just before the summer break. Rather than traditional professional development, the district encouraged teachers to explore the devices on their own:

> That was pretty cool, though, because it was like, "Happy summer. Here's an iPad; go play." That was actually…I kind of liked the way that worked out because then you could figure out e-readers and everything else that summer. A lot of times when you come back and you get staff development in August, it doesn't take very well. Because there's so much else going on in August.

Celeste's experiences were typical of other teachers' experiences in my study. For example, Susan, the middle school CTE teacher, recalled the year she first started using

the bridge-building software that she has now incorporated into her regular curriculum. She had to explore it on her own over the summer: "I spent almost 3 weeks here at school on the computer…working with that program. And that was 2 years ago. I was teaching myself." Like Celeste, the lack of alternative options for professional learning pushed Susan to use an informal, exploratory approach. In contrast to Celeste, Susan had an additional motivation to follow informal learning pathways. As the only CTE teacher at the middle school, she did not have easy access to colleagues who could guide or enhance her technology-related learning. Recall from Chapter 2 that when a technology is very new (Kessler, 2007) or teachers do not have nearby colleagues available for collaboration (Voogt, 2010), informal learning might provide the support teachers need.

One benefit of teachers' exploratory technology-related learning was that it continued well beyond their first introduction to a new technology. Teachers shared anecdotes similar to Brianna's experience with the Boardmaker software: "I've been playing with it for about 7 years now and I'm still learning new things." When I followed up and asked about her exploratory technology-related learning in general, Brianna shared, "I do that all the time. All the time. I think it's just sometimes easier to try it out and work through it, than try to sit and read directions." Here, Brianna was also alluding to her preference for learning through informal, exploratory pathways. I will discuss the role of teachers' learning preferences later in this chapter. Similar to Brianna, Ashley shared, "That's the best way I learn. I click around by myself and make my own test just to play around and see what I can do." Karla also echoed this idea, saying she often learned through exploring: "You think, 'It must be here somewhere.' So you click on the tabs and you scroll and think, 'Is it here? Is it here?' And then finally you come across

something and it works." The shared experience of teachers in my study was that exploratory learning represented an important informal learning pathway.

However, exploratory learning is not without its limitations. Just like with learning through trial-and-error, teachers in my study eventually grew frustrated with the clicking and pursued learning through other pathways, like asking an informal technology mentor for help. When Quinney, Smith, and Galbraith (2010) observed 96 college librarians' voluntary, self-directed learning about technology, they noted experiences similar to those of the teachers in my study. Librarians in their study shared that they enjoyed exploring technology independently, but only as long as they experienced frequent success. This, along with the experiences the teachers in my study shared, suggests there might be a limit to the value of exploratory learning. Consider that Karla and Ashley both shared that they like to learn by clicking on things, but for different reasons. However for Karla, if the clicking did not eventually lead to success, she grew frustrated and stopped using the tool altogether.

As I talked with participants about the specific modes of informal and incidental learning they used when they were exploring, two common themes emerged. The teachers in my study often watched videos and/or read printed texts, like manuals, when exploring to learn more about technology.

Videos. Throughout our talks, the teachers in my study referenced times when they learned about new technology (or using existing technology in a new way) by watching a video. In some cases, these videos were formal, polished productions, like webinars created by vendors or product representatives. In other cases, they were short informal clips, like the tutorials created by the district's TSTs to demonstrate Google

Drive. In still other cases, they were completely informal, unedited videos that teachers and students had shared on YouTube, demonstrating ways they were using technology in the classroom. Along with the variability in the quality of videos watched, there was also variability in teachers' approaches to finding videos. Some of the teachers in my study purposefully sought out videos as a means of continuing their informal technology-related learning. Others stumbled across them incidentally. A few received links to videos as part of a troubleshooting process with an informal technology mentor. Regardless of the quality of the video or their means of finding it, there was no consensus among the teachers in my study about this mode of technology-related learning.

For the teachers in my study, learning about new technology by watching videos was almost exclusively a matter of personal preference. Some of the teachers in my study were positive about watching videos to learn (James, Melissa, Susan, and Ashley); others were neutral or ambivalent (Brianna, Celeste); one was negative (Karla). Among those who did sometimes learn about technology by watching videos, there were some areas of overlap. For example, most participants who reported learning from watching videos also shared something similar to Brianna's reflection that "videos aren't enough for me." These teachers found themselves needing additional support or learning even after watching a video that addressed their learning need. Melissa shared that the new 3-D printer she bought included online training: "The training was done online through a live videoconference. But they also had some YouTube videos that reiterated what the videoconference was teaching us." However, after the training, Melissa found herself needing additional information and reminders to apply what she had learned. She thought this would be true for many of her colleagues as well.

For James, Susan, Melissa, and Ashley, videos were a stand-in for informal technology mentors. James, the elementary school TAG teacher and the most avid video-user in my study, relied on videos, in part, because none of his colleagues were using the same technologies in the classroom. He shared,

> For the coding and robotics with the kids, I'll start with videos. To try to find a way…just yesterday, we were trying to find a way to make the [robot's] obstacle detectors a little more accurate and I was looking online for some sort of way to make it more efficient. And I saw a couple of YouTube videos that we watched.

In this example, James was engaged in several modes of informal and incidental technology-related learning. He had a learning need—to make the obstacle detectors more accurate—and decided to research his problem online. He then stumbled across relevant videos and watched them alongside his students. Throughout this experience, he was also engaging in trial-and-error learning. Videos were a just in time support for James's technology-related learning need.

Similarly, Susan, the middle school CTE teacher, relied on videos for troubleshooting, after finding that her TST could not help her with her 3-D printer. She shared,

> Before I called [technical support], I went on YouTube and typed in [the name of the 3-D printer] and did a whole bunch of YouTube videos trying to figure out how to convert the STL language into something that would actually print. And I got nowhere.

Despite not finding a solution to her original problem, Susan shared that she still enjoyed watching the videos. They introduced her to the potential of her new tool and made her

excited to continue researching the installation problems she had encountered. In contrast, Ashley, the high school math teacher, knew that videos were an option for troubleshooting and learning about new teaching ideas. However, she did not always turn to videos as a primary source of learning. Referring to her attempts to integrate her new interactive whiteboard into daily instruction, Ashley shared, "I'm sure YouTube, if I just Google this exact model, has probably a nice video on how to set it up how to use it and examples of how to use it in the classroom." Ashley was reluctant to do this kind of research, in part, because she knew she would have to stay at school additional hours for her troubleshooting to be effective. She could not take the interactive whiteboard home with her, so her learning would have to happen in the classroom. I will discuss this limitation in greater detail later in this chapter.

For Karla, the high school world languages teacher, the idea of learning from videos as so unappealing, she said she would not consider watching one: "I hate it when the school sends out instructions [and tells us to learn by] watching a video. I don't do that." In contrast to several other participants in my study, who referenced the TSTs' support videos in a positive light, Karla refused to watch them. This type of aversion to a particular mode of learning bolsters the argument that school districts should be cautious about neglecting any one form of teacher learning in favor of another; there will likely always be some teachers who, like Karla, avoid learning in certain modes. Learning from watching videos was highly preference-driven for the teachers in my study. I will discuss the role of teachers' learning preferences further later in this chapter.

Printed texts. For three of the teachers in my study, printed texts, like user manuals, instructional packets, and newsletters, were often an important supplement to

other types of technology-related learning. Two of the teachers in my study, Karla and Susan, expressed a preference for printed versions of digital texts. For example, when the IT department sent digital instructions for the school district's new gradebook program, Karla reflected: "They send you tutorials and sometimes I'll print that out and have it next to me on my desk and look at it and follow it step by step." For Karla, it was cumbersome to complete computer activities while also referring to instructions that were digital and displayed on the computer. Similarly, Susan expressed frustration that her new 3-D printer did not come with a printed user manual, but a digital version was available online. She shared:

> I downloaded the manuals to each part of that program; I think it was five parts. Because I'm a visual person, I can't just do it on the computer. I had to make the manual, so I printed it. So now I have a book and from that book I can sit down and I can actually read information that I can then turn into a lesson.

For Susan, digital versions of the instructions were a barrier to her informal learning. She needed to have printed copies, which she could then flip through and use as a reference as her learning needs arose.

In contrast, Melissa, the high school CTE teacher and administrator, was comfortable with both print and digital texts, but sometimes relied on printed text because of her need for specialized content that was not available online. She shared that she taught herself a new skill, in advance of teaching her students, by reading the textbook and user manual that went with specialized computer aided drafting software. For this subset of teachers in my study, printed texts were an important source of informal learning.

The two learning pathways that I have discussed so far—learning through trial-and-error and exploratory learning—both involved teachers relying primarily on their own abilities to figure out how to use technologies in the classroom. In the next sections, I will talk about the ways teachers in my study leveraged the collective knowledge of their peers and colleagues to further their technology-related learning. This included collaborating with peer teachers, identifying informal technology mentors, and learning from vendors and product representatives in a variety of settings.

Peers and Colleagues: "He was teaching me before I taught the kids"

Teachers' peers and colleagues are one important source of their informal and incidental learning about technology. Recall from Chapter 2 that researchers have previously recognized teachers' informal conversations with colleagues as a valuable pathway for learning (W. M. Jones & Dexter, 2014; Lohman, 2003). As expected, when I asked the teachers in my study about their informal and incidental learning from "talking to others," they often shared stories about learning from other teachers who worked in the same building.

An unexpected finding that emerged from our talks was that many of the teachers in my study also shared about learning from two other types of people: informal technology mentors, such as the Technology Support Teachers (TSTs) in the district or a designated colleague who they viewed as tech-savvy, and vendors or product representatives. The ways teachers learned from these three categories of colleagues—peer teachers, informal technology mentors, and vendors or product representatives—were related, but also distinct. Because of this, in my analysis, I differentiated between the learning teachers did from other classroom teachers, like those who participated in my

study; the TSTs or other informal technology mentors; and the vendors or product representatives who teachers in my study encountered in a variety of settings.

Peer teachers. In some cases, teachers in my study collaborated with a colleague from the same content area and the two teachers learned alongside one another. Melissa, the high school CTE teacher and administrator, shared that a colleague in her department, "found some great videos that the publisher of our textbook actually had developed. Since I hadn't taught the course in a while, I hadn't seen the videos yet." In this example, Melissa's colleague—who had engaged in her own informal learning prior to meeting with Melissa—became an important source of informal learning for Melissa, by locating relevant reference materials and sharing them. Melissa not only benefitted from her colleague's prior investment of time, but also learned from the collaborative conversation that followed. Celeste, the second-grade teacher echoed this idea when she shared,

> There's a teacher here who [set up] a listening station, after I had. So we had great discussions about what I had found worked best with uploading books…. She was really lucky that she could jump on my bandwagon; I had done a lot of the trial-and-error. And I had learned some things from another teacher who had done it.

Here, Celeste had previously engaged in her own informal learning about listening stations—through conversation with another classroom teacher trial-and-error—and then passed along what she learned through informal conversation with yet another classroom teacher. Celeste's experience is similar to what several participants in my study shared. Frequently, when teachers acquired knowledge informally or incidentally, they passed it along to another teacher. This is related to previous research, where Collinson and Cook (2004) found that sharing technology integration knowledge "tended to be informal,

specific, and exchanged in small doses" (p. 130). Similarly, when Hobbs and Coiro (2016) observed teachers collaborating to increase their digital literacy, they noted that peer collaboration supported teachers' reflection on learning and willingness to take risks with learning new technologies. Yet, this only happened after teachers chose to come together for the common purpose of professional learning related to technology integration (Hobbs & Coiro, 2016). The influence of context, which I will discuss in greater detail later in the chapter, was also evident in teachers' experiences learning from peers and colleagues. When teachers had close relationships with their colleagues, there was a natural give and take of learning between and among the colleagues. The collective knowledge of the group benefited each individual member.

For some of the teachers in my study, the sharing of knowledge between colleagues extended beyond the school building. Brianna, the special education teacher, shared the example of attending a workshop where a vendor demonstrated new technology to a group of special educators. She said her learning at the workshop came, "not from the people who were pitching, but from other teachers who were there. We got to talk about some different technology we're using across districts." Brianna and several of her colleagues from Dogwood Public Schools continued to collaborate with the teachers they met at this workshop. Susan and Melissa shared similar stories of learning from out-of-district colleagues they met at conferences. I will discuss their experiences in further detail later in this chapter. For Brianna, Susan, and Melissa, out-of-district colleagues became an important source of informal and incidental technology-related learning. This is similar to the teachers in Mueller and Welch's (2006) study of teachers learning to integrate technology alongside students. During the course of the study, the

teachers in Mueller and Welch's sample formed themselves into a community of practice and reported learning informally from their interactions with colleagues. Recall from Chapter 2 that the term "communities of practice" is somewhat fraught—where they exist in their naturally occurring form, their members might not realize they do (Printy, 2008; Wenger, 2006). This seems to apply to Brianna's experience, and, to a lesser degree, the experiences Susan and Melissa shared, which I will discuss later in this chapter.

Again, and as might be expected, teachers' learning from peers and colleagues was more heavily influenced by context than some other modes of informal and incidental learning. Teachers in my study who had close ties with many colleagues throughout the building were more likely to report learning about technology from those colleagues. Teachers who had comparatively weaker ties with colleagues, like Karla and James, were less likely to identify with this learning pathway. In some cases, the connections teachers did have were not useful in supporting their technology-related learning. For example, when Karla had a question about her gradebook, she went to a colleague to ask for help, but the colleague did not have a solution; then Karla, "[ran] around in the building trying to see who [had] a planning period and [was] available and might be able to help me." Karla's network of peers and colleagues was not supportive for her technology-related learning. This is an important limitation of teachers' learning from peers and colleagues, which I will discuss further in Chapter 6.

Informal technology mentors. Although teachers' learning from informal technology mentors was subject to similar contextual influences as their learning from peers and colleagues, there were distinct differences in these interactions. Teachers in my study tended to have weaker ties with their informal technology mentors and fewer

connections overall, relative to the number of connections they had with other types of teaching peers. In other words, although teachers in my study frequently collaborated and learned from many different peers, most had only one or two informal technology mentors who they consulted for their technology-related learning needs. For the teachers in my study who taught in the same building, they often identified the same informal technology mentor as a resource for their informal and incidental learning. For example, Karla, Melissa, and Ashley—all high school teachers—reported learning about technology from the same TST assigned to the high school. Although Melissa had formed connections with other informal technology mentors, and self-identified as an informal technology mentor to other teachers in the district, for both Karla and Ashley, the high school's TST was the only informal technology mentor they reported learning from.

Every participant in my study had positive opinions of the support offered by the district's TSTs. Celeste, the primary school teacher, shared, "the fact that we have an almost-fulltime TST at our school is a great thing. I think it's fabulous that we have that resource. It's very helpful." Similarly, Susan, the middle school CTE teacher, shared her experience of learning to use flight-simulation software from the TST at the middle school:

> He was teaching me before I taught the kids how to fly. We sat down, the two of us, together. At that time, we didn't have a yoke; we had to do it with a keyboard. And then he found the yoke for me on a website somewhere.

In Susan's case, the TST was a source of both informal and incidental technology-related learning. On an unrelated visit to her classroom, the TST happened to mention flight simulation software he had used in a previous job. Susan became interested and did

additional research to learn more. When she decided to order the software, she asked the TST to return to her room and help her learn to use it. Other teachers relied on the TSTs for more basic types of support. Ashley reported that she rarely relied on the TST at the high school for her own professional learning, but she did value having someone she could ask troubleshooting questions.

The teachers in my study also viewed their informal technology mentors as a formal support for their ongoing technology-related learning in that they were people they could go to when a learning need arose. Brianna shared that when she heard about a new technology incidentally, she knew she could, "go and seek out more information about it through Google or through our TST." Similarly, Melissa shared that when she has a technology-related learning need, she "might have side conversations with someone I know is tech savvy in the same way I am and who is using technology to make some learning processes more efficient." James had developed an ongoing collaboration with the elementary school's TST as the two worked together to implement a new robotics project. This relationship was particularly important for James because he was relatively more isolated from his other peers and colleagues than other teachers in my study. Recall from Chapter 4 that James's unique teaching and coaching responsibilities prevented him from attending grade-level meetings, PLC meetings, and many of the formal professional development offerings at the elementary school. Further, as the only TAG reading and math teacher at the elementary school, he was integrating technologies that his colleagues were not. In many ways, the TST was James's only source for collaborative technology-related learning.

For many of the teachers in my study, interactions with informal technology mentors were opportunities for incidental learning. For example, Brianna shared the experience of helping to develop a box of literacy materials for special education teachers in a neighboring school district:

> I did a box based around transportation, so there were all different types of activities in this box about transportation. Some of [the material] was books and that's where I learned about the Sparkup reader. [An informal technology mentor] showed us how you could use it to create read-alouds.

Brianna did not expect to encounter a new technology when she agreed to help her colleague from a neighboring school district. However, when she did stumble across the Sparkup reader, a colleague who was also in attendance quickly showed her how the device worked. Brianna later continued her technology-related learning along informal pathways, researching the device online and deciding to purchase one for her own students.

Some researchers have suggested formalizing the support teachers receive from their informal technology mentors, by following a "collaborative apprenticeship" model (Glazer, Hannafin, & Song, 2005). This model builds on the communities of practice framework (see Wenger, 2006) to pair informal technology mentors with teachers who need support integrating technology. Similarly, Hobbs and Coiro (2016) observed that teachers in their collaborative professional development workshops learned best when tech-savvy colleagues were available to provide support. I will explore the idea of formal supports for teachers' informal and incidental technology-related learning later in this chapter as well as in Chapter 6.

Vendors and product representatives. An unexpected source of informal and incidental learning, and one that is perhaps unique to teachers' learning about technology integration, was learning from vendors and product representatives. Although it might be a stretch to consider vendors to be teachers' colleagues, the interactions teachers in my study had with vendors were, in many cases, very collegial. Six of the seven teachers in my study reported having learned about technology integration from a vendor or product representative. Also unexpected was that much of the learning from vendors and product representatives that teachers in my study reported did not happen at professional conferences (although some of it did). Teachers encountered vendors and product representatives in a variety of settings and often sought out their support as a source for informal learning.

In some cases, teachers' learning from vendors and product representatives was a function of the content area they taught. Melissa, the high school CTE teacher and administrator, shared:

> With CTE, you have a lot of equipment. Because we are hands-on courses, [we] have a lot of equipment and supplies. We meet frequently with vendors. Usually they will provide some training on how to use the equipment that's included in the initial purchase. So I have figured out how to use equipment through vendors. The last couple of times I've bought things, the vendors have provided the training virtually, online or through a webcast, or YouTube videos, or something of that sort. That's pretty common.

Although the initial training vendors provided was often closer to formal learning modes, Melissa, the high school CTE teacher, shared that she frequently had follow-up

conversations with vendors to help her learn to use new equipment. The specialized equipment required for the content area she teaches necessitated Melissa's informal learning. Few other colleagues in her school or district were likely to have expertise related to this equipment. Similarly, Susan shared that one reason she enjoys attending professional conferences is because, "You get to see the vendors and it's like show-and-tell. They show you all these wonderful things….It's really cool seeing them at the conference and actually putting your hands on [the technology]. That's how you get started." In Susan's case, vendors were also an important source of incidental learning, providing the initial exposure to new technology (and new uses for existing technology) that piqued her interest in learning more, usually along informal pathways.

However, the teachers in my study who taught more traditional academic subjects also reported learning from vendors and product representatives. Ashley, the high school math teacher, shared about a vendor who attended a faculty meeting and demonstrated a new game-based learning site the district was considering subscribing to. This formal presentation provided an initial exposure to and training for the software, but Ashley continued her learning informally. Initially, Ashley was interested in the vendor's site, but found that the reality did not match her expectations: "I went on [the site] to see what kind of Calculus things they offered and it was only two items. Every other class had hundreds of items. So that was kind of a little bit of letdown." Despite the fact that she did not end up using the particular software the vendor had demonstrated, Ashley enjoyed the presentation and credited the vendor with giving her some new ideas for using technology in her classroom. James, the elementary school TAG teacher, reported a

similarly favorable learning experience with a product representative who he called for troubleshooting help:

> It was very collegial, where she was trying to promote us to use it. I mentioned that I was using the robots and she had follow-up questions for me—about the robots themselves and how we're using them in class. And she directed me to another website that had more projects to do with [the robots].

Even though the product representative had a financial incentive for helping James, he felt her assistance was motivated more strongly by her genuine desire to help him successfully integrate the technology in his classroom. His conversation with her, which he initiated as a troubleshooting call, resulted in James learning incidentally about additional resources to use in his robotics curriculum.

In contrast to James's experience, Brianna's interaction with a vendor was less positive. The vendor's teaching approach and perceived level of sincerity was a barrier to teachers' learning. Brianna, the special education teacher, shared, "I went to a Boardmaker training recently—what was supposed to be a Boardmaker training—but it was a sales pitch for Boardmaker online. It felt like a sales pitch." Brianna had been using the Boardmaker software for many years and was looking forward to learning about its new features at the presentation. She was highly motivated to engage with the vendor and ask questions. However, the vendor's approach—selling rather than teaching—was unappealing. Similarly, Ashley, the high school math teacher, shared that despite enjoying the math software demonstration at her school, "at some points it was a little too much of [the vendor] trying to prove all the things he knows, and show how smart he is,

rather than exhibit this technology to us." In both cases, the vendor's approach to demonstrating the software inhibited the teachers' learning.

Because of their relatively more formal nature, these vendors' presentations were also limited in some of the ways I presented in Chapter 2. Celeste, the primary school teacher, shared that even the best vendor presentations were usually not enough to satisfy her learning needs:

> You're going to have to figure it out on your own. There's just so much that comes with these new systems. They've got all of the print materials you have to learn about and on top of that they've got all of the online and technological part of it. You can't possibly figure it all out [in one session].

Celeste reflected that formal presentations by vendors often felt rushed, with too many learning objectives "crammed in" to one day. Further, the presentations were often scheduled for very busy times of the year, such as just before school started. Celeste expressed frustration that it was hard for her to absorb all of the new information in one sitting. Recall from Chapter 2 that a major advantage of informal and incidental learning is that they may fill in the gaps left by formal professional development (Lohman, 2003), including formal vendor presentations like the ones Celeste described.

There is little in the extant literature related to teachers learning from vendors or product representatives, suggesting this might be a relatively new occurrence. It was clear from talking to my participants that the interactions with vendors that they found most useful were those that felt authentic and collegial, rather than like a sales pitch. This aligns with a brief opinion piece written by school librarian about the potential for collaboration between vendors and school librarians. Ray (2013) wrote,

> I have heard several teacher librarians saying that were it not for vendor-sponsored training, they would have no access to professional learning or networking. Realizing this, vendors are increasingly stepping in to fill these gaps with real or virtual professional development offerings. (p. 57)

Ray went on to outline the many ways vendors have helped him build his professional network, leading to further professional learning opportunities, and stay up-to-date with educational technology offerings through phone calls, emails, and webinars. These interactions closely mirror the experiences participants in my study shared with me.

Other Learners: "Mom, did you know Google can do this?"

The teachers in my study often learned about technology informally and incidentally with and alongside other learners, like their students and their own children. For example, Susan, the middle school CTE teacher, shared about a problem she was having with her 3-D printer. After trying unsuccessfully to resolve the problem on her own, she decided to accept a student's offer for help: "He stayed after school a couple of times and he got it working. It was surprising. He was so pleased with himself—I was, too—he took his time to do it, rather than me, then he taught me." In Susan's case, there were several barriers to her learning: the printer was not working, so she could not begin to learn to use it; her time was limited, so she could not continue troubleshooting on her own during work hours; and the printer was large, so she could not take it home and continue troubleshooting on her own after work hours. She relied on her student to supplement her learning. Susan's experience relates to findings from Mueller and Welch (2006), who conducted research on teachers' professional learning alongside students. The researchers found that teachers in the study benefited from learning about technology

with and from their students, which encouraged them to reflect on their own practice in real time.

Teachers in my study also learned from their students incidentally. Ashley, the high school math teacher, shared, "If the kids are talking about something and I overhear it, then I usually asked them if this would be something they would want to do. Or I try to Google it myself after overhearing them." Recall from Chapter 4 that Ashley has a student-centered approach to teaching; she is very responsive to her students' learning preferences. Ashley shared that she frequently tried new technology in the classroom as a result of overhearing students express interest or enthusiasm about another teacher using the technology. Similarly, Karla, the high school world languages teacher, reported that her students asked her to use a new mobile application that other teachers at the high school had used to remind them of important due dates. Then, "some students actually helped me install it on my phone, and now I can remind students of upcoming tests and quizzes. I am so hip!" Despite her overall aversion toward technology, Karla was open to this student-generated incidental learning experience. What Ashley and Karla shared was similar to Fortuna's (2016) experience early in her teaching career. Learning about technology from her students pushed her to integrate technology in ways she would not have otherwise considered. For both Ashley and Karla, the high school's new Bring Your Own Device (BYOD) initiative also influenced their learning, but usually only in incidental ways. The ready availability of students' mobile devices slightly increased the opportunities to learn from and with their students. I will discuss the role of this important contextual element later in this chapter.

Teachers in my study also learned from their own children, at home and in online spaces. Brianna, the special education teacher, shared examples of learning to use Google Drive from her son, who is a student in the same district where she works:

> He's using Google Classroom right now and…he tells me about how he's using it and what he's doing and, "Oh we're using this to make slides." He'll get on and show me, "This is what I made for class. Mom, did you know that Google can do this?"

Brianna's learning began as an incidental exposure to the way her son was using technology, but continued later along informal pathways. After further exploratory learning, she began to integrate Google Slides in her classroom. Similarly, Susan recalled a time when she transferred learning from home to classroom after seeing the ways her own children interacted with a new technology. She shared that a birthday gift for her son later became part of her CTE curriculum:

> I ordered it for my son. He was 6 or 7 at the time. He went nuts with it and then all my other kids wanted to play with it, too, so I thought, "Huh, there's something pretty good here."

Although her sons are now adults, Susan continued to learn about technology from them, saying, "We're on Facebook together and every now and then my son will send me a link and I'll go take a look. So actually, my sons are teaching their mom." Karla also learned from her adult son. In an email to me, she wrote, "I am waiting for my son to get back from his job…and help me figure out how to make a screenshot on my MacBook." For Brianna, Susan, and Karla, their own children were an important source of informal and incidental technology-related learning.

There was an important contextual component to this sort of learning. The teachers in my study who had more student-centered classrooms, like James, Ashley, and Susan, were relatively more likely to share examples of learning about technology from or alongside their students. Brianna and Celeste, who worked with very young students, did not report learning about technology directly from their students, but did share examples of learning through trial-and-error alongside their students, suggesting that potential exists for many types of teachers to engage in this mode of informal and incidental learning. I will discuss further considerations of classroom context in more detail later in this chapter.

Professional Conferences: "Where you find out about some new technology"

As expected, the technology-related learning teachers did at professional conferences happened along many pathways. In some cases, teacher in my study reported learning about technology from formal, structured conference sessions. Melissa and Susan, the high school and middle school CTE teachers, both reported many learning experiences that took place at professional conferences. When I asked about an annual CTE conference Melissa attends, she said,

> I think it's important [for my technology-related learning]. It's usually where you find out about some new technology that's being developed or available. You might go to a workshop with a teacher who's using it, who can tell you about the problems they've encountered with trying to get it to work properly. Some tips and tricks to use. I think it's important. I usually walk away from a conference with at least one [technology] thing I've learned.

Melissa reflected that her learning at professional conferences was often a good mix of learning from formal presentations and informal or incidental interactions that happened to occur while at the conference.

Of the teachers in my study, Susan was the most avid conference participant. From our first talk, she shared that she found professional conferences to be one of the most valuable sources of her technology-related learning. Susan reflected:

> In a conference, it's usually during the summer, when you're away from students. And you can actually focus on what you're learning.…And then of course you can talk to your fellow teachers who are all standing around ogling. They say, "I've tried this and I've tried that and this one is better than that one." So you compare notes with other teachers at these conferences.

Susan indicated that, although she often learned from the formal presentations at conferences, some of her most valuable learning at conferences came from informal conversations with colleagues and incidental encounters with vendors and product representatives. Susan often used conferences to generate new ideas, and then followed up on those ideas later with her own informal learning.

For most of the teachers in my study, including Melissa and Susan, much of the learning that took place at professional conferences happened outside of formal sessions. The teachers in my study found that their formal learning at conferences was often limited. In part, the limitations of learning at conferences were similar to the limitations of formal presentations shared in Chapter 2: a generic, one-size-fits-all, "sit and get" session was not the most effective model for their professional learning. For example, Celeste, the primary school teacher, shared that in one technology-learning session she

attended, “really a lot of that was for secondary education. I didn’t find it as helpful for primary.” Despite signing up for what looked like an applicable conference session that would help her integrate technology in the classroom, Celeste was frustrated to discover the session was designed for teachers of older students. She enjoyed the session, but it did not address her learning needs and she was unable to apply what she had learned in the classroom.

Celeste’s experience was one example. For several of the teachers in my study, conference offerings were a bad fit for their learning needs. Melissa shared that she found her learning at a recent conference was limited: “When I signed up for the workshops, a lot of them were already full. So I didn’t pick the things that I wanted to learn the most about necessarily.” In Melissa’s case, a delay with district funding for her conference registration became a barrier for her learning. Her late registration meant that she had to choose from sessions that were not her first choice and negatively impacted her professional learning at the conference. Similarly, James, the elementary school TAG teacher, found that even when he attended a conference session related to technology he was using in the classroom, the knowledge did not transfer to his classroom because no new-to-him information was presented. Instead, “what happened at the STEM conference is that I was glad to see that what I’m doing is the right thing for the kids, I think.” James appreciated the validation he got from attending the conference session, but did not take away any new learning.

Karla, the high school world languages teacher, and Ashley, the high school math teacher, simply chose not to attend professional conferences very often, in part because of prior bad experiences. Karla shared that the conferences she had attended were, “more

content than technology." Another consideration in Karla's case was her aversion to learning about technology. Karla reflected that she probably would not choose to attend a technology-themed session at a conference if there were other relevant sessions being offered. Similarly, Ashley shared that the combination of financial considerations and the limits on her own time made conferences unappealing. Applying for conference funding from the school district took time and energy Ashley would rather expend elsewhere. She also felt that creating plans for a substitute to cover her class would be more work than the knowledge she might gain from attending a conference. Ashley preferred to pursue professional learning needs in other ways. I will discuss this possible limitation of teachers' informal technology-related learning in Chapter 6.

There is some evidence to suggest that a formats such as "unconferences" and "Edcamps," which are participant-led gatherings of educators who come together to learn from and with one another, might bridge the gap between formal conference presentations and informal and incidental learning experiences that happen on the periphery of traditional conferences (Carpenter, 2016). For teachers like Karla and Ashley, who are reluctant to attend professional conferences, these conference-alternatives might provide a valuable pathway for learning. Carpenter (2016) surveyed over 90 teachers who had voluntarily participated in an Edcamp in order to collaborate and learn from other educators. The overwhelming majority of teachers surveyed enjoyed their Edcamp experience and found it useful for their own professional learning. However, the participants' criticisms of the Edcamp experience echoed criticisms the teachers in my study noted about their conference experiences: in some cases, the offered sessions did not meet their learning needs or align with their interests (Carpenter, 2016).

Professional Learning Communities (PLCs)

Recall from Chapter 2 that there is no clear consensus in the extant literature regarding how effective PLCs are for teachers' learning, in general, and for teachers' learning about technology, in particular (e.g., Stewart, 2014; Thessin, 2007; C. M. Wells & Feun, 2013). Further, recall from Chapter 3 that, in order to investigate the possible role of PLCs on teachers' informal and incidental technology-related learning, I recruited a purposive sample of teachers, some of who worked in schools with active PLCs. Recall from Chapter 4 that Brianna, Celeste, and James taught at schools with active PLCs; however, James's teaching schedule precluded him from participating in PLC meetings. Although an attempt had been made to start PLCs at Susan's school, at the time of my study, she was not participating in a PLC. Because the high school had not attempted to form them, Melissa, Ashley, and Karla were also uninvolved in PLCs. Although PLCs were not a central focus of my study, the information participants shared with me related to their participation in PLCs aligned well with the extant literature on this topic.

For the teachers who participated in my study, PLCs were not typically an important part of their technology-related learning. Celeste shared, "we have [PLC meetings] every Thursday. It's not really professional development. I don't know that we do any technology learning during a PLC because really it's just looking at data and different children." Celeste did share that, when PLCs first began, the PLC facilitator had given a brief demonstration of how to use the data collection tools the group would be using, but beyond that, technology-related learning in PLCs had been very limited. Brianna's experience with PLCs was slightly different from Celeste's. Brianna participated in weekly grade-level PLC meetings as assigned by her school administrator,

but also participated in a separate PLC meeting of her choosing. The special education teachers at the Dogwood Primary School voluntarily formed their own PLC, which met monthly. In these monthly meetings, Brianna shared, "we often will take the information we learn [at a conference] and talk about it and share it at our PLC meetings and teach the other special ed. teachers how to use it." Brianna made a clear distinction between her two PLC experiences. When I asked her if she learned about technology integration during grade-level PLC meetings, she said that learning was very limited; the group had learned about using Google Drive to organize student data, but otherwise did not use PLC meetings to learn about technology integration. This was consistent with what Celeste shared. Although James did not participate in the elementary school's PLCs, he did not have a positive impression of what went on during the meetings. He shared that his colleagues reported being frustrated with PLC meetings and reflected, "I don't know if we're running PLCs the way they were designed."

For the teachers who participated in my study, PLCs were not the best setting for their technology-related learning. Still, I found that PLCs did play a role in the contextual landscape of the two schools that had them. Similar to Kitchenham's (2009) conclusions in a multiple case study of school culture, it seemed that the teachers in my study who actively engaged in PLCs (Celeste and Brianna) were also more highly connected to peers and colleagues in their building than the teachers who were not involved in PLCs (James, Susan, Melissa, Ashley, and Karla). However, it is important to note that this could be simple correlation; other factors, such as the nature of teaching younger students versus high school students, could have been the root cause of increased collaboration. One limitation of technology-related learning during PLCs might also be the physical

space where PLCs are scheduled. Raible and LaRowe (2015) have suggested that when physical spaces are not designed to accommodate technology-related learning (e.g., lack of technology in the meeting room), technology-related learning is unlikely to occur.

Personal/Professional Learning Networks (PLNs)

When I asked teachers in my study about their use of social media, newsletter or magazine subscriptions, and other examples of components of PLNs, only Melissa, the high school CTE teacher and administrator, reported substantial technology-related learning associated with those channels. However, she was mainly a recipient of learning and rarely a contributor to others' learning and did not maintain a regularly curated PLN. None of the teachers in my study maintained the collection of digital and/or print resources combined with key mentors required to meet the standard of a true PLN (see Bauer, 2010; Nussbaum-Beach, 2012).

When I asked teachers about their informal and incidental technology-related learning, one unexpected learning pathway that emerged was teachers' use of Pinterest. Pinterest is a social media platform that represents a virtual bulletin board. Users create virtual boards and then "pin" ideas—usually pictures associated with links to outside websites—and view other users' boards. Although it does not meet several of the key characteristics associated with PLNs, Pinterest does allow for user-directed learning, an exchange of ideas, and the combination of multiple streams of information. Recall from Chapter 2 that these are characteristics associated with PLNs (Nussbaum-Beach, 2012). Celeste, Brianna, and Melissa all reported using Pinterest to organize teaching ideas, including ideas related to classroom technology. In an exploratory study of teachers' professional use of Pinterest, researchers concluded that the platform could play a role in

teachers' professional learning and connection to colleagues beyond their school or district (Carpenter, Abrams, & Dunphy, 2016). Yet, when pressed, the teachers in my study could rarely name specific examples of learning via Pinterest. So although they were active users, it is hard to quantify how much professional learning arose from this use.

Another unexpected finding emerged when I asked teachers about their use of Twitter. My review of literature related to teachers' learning in online spaces, like Twitter, led me to expect that at least some of the teachers in my study would be actively engaged in professional learning along these pathways (e.g., Evans, 2015; Oliver, 2016). Although several of the teachers had Twitter accounts, again only Melissa used her account for professional learning. She shared,

> I use Twitter and I follow several professional organizations. If I find something about technology through that, it would be just an incidental learning experience. But I do try to keep up with my professional organizations and their newsletters and Twitter and stuff like that.

A more typical response was Ashley's reflection that, "I have subscribed to a few things on Twitter, but I don't really pay attention to it. I'm not really big on social media and that type of stuff." Consistent with other research on this topic, teachers like Ashley and Celeste cited lack of time for using social media for professional learning (Goodyear, Casey, & Kirk, 2014; Oliver, 2016). About Twitter, James, the elementary school TAG teacher said, "It sounds like a great place to go, but [during my coaching season] I definitely don't go outside to find anything for class unless I stumble upon it." Again, the

time required to maintain a beneficial PLN was a barrier to teachers' use of this potential mode of technology-related learning.

Teachers in my study regularly learned about technology along informal and incidental pathways. They learned through trial-and-error, deploying new technology in the classroom to see how students responded. They learned through exploratory learning—"just clicking on things," watching videos, or reading printed texts—to solve problems and test new tools. They learned from conversations with their peers, including informal technology mentors and vendors or product representatives, in a variety of settings. They learned from their students and their own children. They learned at professional conferences, both from formal presentations and informal or incidental interactions with colleagues and vendors. A few learned from involvement with a PLC or PLN. Collectively, across grade levels, content areas, and teaching contexts, the teachers in my study learned about technology along many, varied informal and incidental pathways.

Discussion

In each of the pathways to learning presented it the previous sections, and in teachers' tendency to combine many pathways in order to meet their professional learning needs, there was evidence of the advantages—as well as the limitations—of informal and incidental learning. These informal and incidental pathways to learning appealed to teachers because they were personalized, timely, and aligned with teachers' learning preferences. Teachers' informal and incidental learning was also influenced by layers of formal support available to them and by their unique teaching contexts. In the following sections, I synthesize these ideas, looking across teachers' experiences to draw

tentative conclusions about the phenomenon of teachers' informal and incidental learning about technology integration.

Personalized Learning: Finding a "Just Right" Fit

A key feature of informal and incidental learning is that it is personalized. Each of the teachers in my study shared that they appreciated learning experiences that were tailored to their learning needs. This mirrored Lohman's (2003) findings; teachers in his study reported a major advantage of informal learning versus formal learning was that it allowed them to go beyond the limited scope of generic, formal professional development sessions and meet their own learning needs. James, the elementary school TAG teacher, expressed his frustration with how slowly whole-group professional development sessions moved, saying, "My pace is usually quick….As soon as I see it, I want to go use it. I don't want to sit around and keep discussing possibilities." Because of this, James found himself drawn to personalized pathways of learning, like watching videos, where he could move at his own pace. Similarly, Susan, the middle school CTE teacher, expressed her affinity for shoulder-to-shoulder technology help: "I would prefer to be sitting down with somebody who's proficient in the program and letting them, us, together working on it." Susan elaborated that the formal presentations and webinars she sometimes attended to increase her technology-related learning often left her with lingering questions about the ways she would actually use technology in her own classroom setting. Like the other teachers in my study, she appreciated follow-up learning that was personalized to her needs and pace.

Teachers' need for personalized learning might also lead them to avoid certain learning pathways. Karla, the high school world languages teacher, avoided whole group

professional development sessions, saying the large crowd made it difficult for her to concentrate because, "it's not personalized enough." Karla appreciated that her school's TST would come to her room, helping her one-on-one, often speaking in German with her. Because many formal professional development sessions at the high school were offered on a voluntary basis, Karla was able to avoid technology-related learning altogether by simply not attending the sessions. Likewise, Ashley, the high school math teacher, shared that she had never attended any of the TST's before-school technology sessions because the topics offered did not pique her interest. She admitted that the TST had been very receptive to presenting topics based on teachers' learning needs, but Ashley felt hesitant to request a presentation based on her personal learning needs. She shared that, although she wanted to learn more about using her new interactive whiteboard, since she was the only teacher in the school who had that particular model of whiteboard installed, it made more sense to ask the TST to come to her room. Like Karla and Susan, Ashley also preferred the shoulder-to-shoulder help of an informal technology mentor.

Teachers in my study also reported that the quality of their informal learning experiences, in particular, was often richer and more meaningful than some of their formal learning experiences. In part, this was because informal and incidental learning allowed them to personalize their formal learning experiences. For example, Melissa, the high school CTE teacher and administrator, was dissatisfied with the formal sessions offered at a STEM conference she attended. Yet, several side conversations she had with colleagues and with presenters yielded important information that helped her personalize

her learning. She found informal pathways, within the formal context of a professional conference, to make the learning opportunities relevant to her needs.

Like Melissa, Brianna, the special education teacher, reported richer learning experiences from her conversations with colleagues than from formal presentations made by a vendor. In Brianna's case, although a formal presentation brought teachers together, the connections they made with one another through informal conversation formed the basis for a loose community of practice. For Celeste, the primary school teacher, the value of informal and incidental learning was something she discovered later in her career. When the school district gave teachers iPads over the summer and told them to "just play around with them," rather than offering any formal training, Celeste found she strongly preferred to have independent time to explore new tools. She felt this independent, exploratory learning allowed her to use the device in ways that were relevant to her students. Collectively, the teachers in my study preferred technology-related learning experiences that were personalized to their needs, interests, content area, and grade level. In many cases, this desire for personalization was met through informal and incidental learning pathways.

The Impact of Time: Timely Learning and No Time for Learning

Teachers in my study reported that their technology-related learning was most useful when it was timely. That is, teachers needed to have access to support at the moment they identified a learning need—otherwise known as "just in time" learning. Recall from Chapter 2 that just in time learning is an important and well established advantage of informal learning (W. M. Jones & Dexter, 2014). Dogwood Primary School had started using Google Drive the year before my study. Celeste shared that when

during the first semester teachers were using Drive, the TSTs offered timely support for the teachers' learning: "very quickly we were given these little PowerPoint presentations that we could go through on our own." Celeste appreciated the fact that, even though no formal professional development sessions were scheduled, the school district still found a way to support her learning about the new technology. Later in our talks, Celeste compared the impact of timely professional learning to hunger, saying she often found formal professional development sessions were scheduled at the beginning of a semester, before she was really ready to apply new technology-related learning in her classroom. She reflected, "You can tell me all day long how to make a grilled-cheese sandwich. But until I'm hungry and I need a grilled-cheese sandwich…I've gotta figure it out [on my own]."

Many of the teachers in my study also talked about saving learning for later. This happened when they learned, usually incidentally, about a new technology or a new use for an existing technology. If they did not have time to put their new learning into practice immediately, they often stored the knowledge away for another time. For example, Melissa shared, "there are [technology] things I'd like to do that are on the back burner….I just don't have time to learn it and figure out how to integrate it into my course." Teachers who participated in a mobile learning study in the UK reported similar experiences (Aubusson, Schuck, & Burden, 2009). Researchers asked teachers about the professional learning they did using their mobile devices, like tablets and cell phones; several reported spontaneously recording or photographing ideas to save for later. However, there was little evidence that the teachers later reflected on the images and videos they had captured (Aubusson et al., 2009). Likewise, for the teachers in my study,

with no practical way to organize those ideas for future exploration, the ideas they "saved for later" were often relegated to an indefinite stasis. This idea is also reflected in Hiltz's (2015) study of teachers' self-directed technology-related learning. Some of the teachers in the study reported a preference for facilitated learning sessions that held them accountable for applying their knowledge and prevented it from being "pushed to the backburner when other responsibilities arose" (p. 3207). For the teachers in my study, saving ideas for later was often equivalent to not using what they had learned.

Related to the idea of "saving it for later," teachers also shared about learning that was lost through lack of application. This often required them to relearn technology-related tasks multiple times. Karla, the high school world languages teacher, reflected that she had learned how to take a screenshot on her MacBook several times, but still could not consistently remember the steps. She said, "if somebody teaches you something about a certain [technology] and you're not using it within the next half year, you're going to forget it." James, the elementary school TAG teacher, had a similar experience in his coding class:

> The program was allowing the kids to use block coding, Python, and Java. The 4th graders and I could not figure out how to toggle through the languages. Even though I had seen it there, I could not figure out how [to find it again].

For James, the fact that he had not used this feature of the program often enough and recently enough to remember it became an obstacle to his own and his students' learning. Because James was the only teacher at the elementary school teaching coding, he did not have a colleague he could ask for help. Ashley, the high school math teacher, shared a similar experience:

> When I first did [a class web] page, I got it perfectly how I wanted it, and 1 month later, when I was ready to do the next unit, I had no idea what I had done previously. So then the whole process started over again, with me playing around, trying to figure out what I did. And eventually I figured it out.

Ashley had to repeat the steps of her informal learning process. Quinney and colleagues' (2010) observations of college librarians' self-directed technology learning revealed similar findings: the librarians were more likely to engage in technology learning and retain what they had learned when they could immediately apply new skills to a hands-on task.

Time was often a barrier to teachers' learning in other ways as well. Recall from Chapter 4 that Karla did most of her teaching preparations at home, away from the school's network. She shared about a time she had found several useful language-learning sites at home, but later realized they were blocked on the school district's network:

> And they say, "Oh, you can email the tech guy. He will make it accessible for you." Yeah, he does. But it takes too long. Sometimes you just want to click on 10 websites and see what they are. And you can't do it. It's not worth emailing the guy; it takes forever.

For Karla (and other teachers in my study) the delay between when she wanted to explore these new resources and when she actually could was enough of a barrier that it prevented her from learning more. Even though there was a solution in place (i.e., email the TST to request permission to view the sites), the delay impeded the "just in time"

nature of Karla being able to explore these sites now. Which, in Karla's case, only increased her antipathy toward technology.

Similarly, Melissa, the high school CTE teacher and administrator, reflected that she sometimes avoided integrating new technology into her classroom because of "the time to learn it, to set it up, and to troubleshoot it. It just wasn't something in my current duties and restraints, the things I have going on, that I could've managed." Melissa and the other teachers in my study frequently referred to their limited time for learning. Although in some cases they could navigate time constraints by fitting in learning between other tasks, Melissa's perspective highlights an important consideration: teachers like Melissa, who know how much time learning new technology requires, might avoid even trying the technology. In short, if teachers do not feel that adequate time for learning is available, they might choose not to learn. Melissa's experience relates to findings in a survey of nearly 300 agriculture teachers in North Carolina: 70% of the agriculture teachers reported that lack of time was a major barrier to their technology integration (Williams, Warner, Flowers, & Croom, 2014). I will discuss the implications of this learning barrier, as well as my recommendations for how teachers and technology leaders can mitigate its effects, in Chapter 6.

Teachers' Learning Preferences

For the teachers in my study, personal learning preferences guided many of their decisions about when, where, and how to conduct their professional learning related to technology. In a previous section, I discussed teachers' desire for personalized learning, which is related to teachers' personal preferences. However, whereas teachers were united in a desire for personalized learning, and their individual anecdotes formed a

consensus related to that desire, their personal learning preferences were as varied and unique as each teacher's personality. For the teachers in my study, personal learning preferences did not coalesce around a central theme; nor were they generalizable to teachers in general. Rather, the only consistency was that teachers in my study could not be categorized as any one type of learner. Although I will discuss the implications of this diversity in greater detail in Chapter 6, I highlight some of these learning preferences here so readers begin to picture the broad range of differentiation that might be required to optimize teachers' learning across grade levels, content areas, teaching contexts, and learning needs.

One example of a non-generalizable teacher learning preference is in the type of operating system teachers used. Ashley, the high school math teacher, and Karla, the high school world languages teacher, both preferred to use their personal Mac laptop computers rather than the district-provided PC desktop computers. This meant that district-provided professional development sessions, which were designed for PC operating systems, were immediately less applicable and engaging for Ashley and Karla. It also meant that Ashley and Karla spent many extra hours transferring files between their personal laptop computer, which they used to develop instructional materials, and the district-provided desktop computer, which were connected to their LCD projectors. Ashley shared that she was trying to adapt to the Google Drive programs the district had recently adopted, since they allowed her to access files at home and at school with no formatting changes, but it had been a slow process and many of her files were still saved to her personal desktop. Karla was not interested in learning Google Drive at all.

Teachers in my study also expressed personal preferences for how and where they learned. Similar to Susan, the middle school CTE teacher, Ashley preferred learning to use technology from an individual, one-on-one, rather than in a formal classroom setting. For Ashley, this included learning from watching videos. Whereas Susan still enjoyed and benefited from more formal learning opportunities, Ashley's personal preference for one-on-one learning was so strong it inhibited her ability to learn about technology in other ways. She avoided professional development opportunities—like professional conferences and formal presentations—that were not delivered in a one-on-one format. In addition to avoiding certain learning opportunities, another consequence of Ashley's strong personal preference was that she often avoided learning altogether. Once she found herself with downtime, she often prioritized other teaching duties over her own learning. She admitted that if her principal or school district had more accountability systems in place (e.g., required attendance at professional development sessions), she would probably learn about and integrate more technology because she would be forced to put her own learning first.

Similar to Karla and Ashley, James, the elementary school TAG teacher, considered his avoidance of professional conferences to be part of his personality. He explained, "I'd rather not go—I'd rather learn on my own, at my own speed." Recall from a previous section that James had been disappointed by the learning opportunities at the professional conferences he attended, finding validation but not new learning in the sessions he joined. Recall also that James's teaching assignment makes him unable to attend grade-level meetings, PLC meetings, and other weekly professional development offered at the elementary school. He feels further isolated from learning from his peers

and colleagues because no other teachers at the elementary school are integrating the technologies he is using. James is an informal technology mentor for many teachers at the elementary school. For teachers like James, who are relatively disconnected from their peers and colleagues, a strong personal preference for one type of learning might severely limit the amount of professional learning they engage in at all. If James limits himself to only learning from videos, he might not do much technology-related learning.

Like James, Karla's, her personal learning preferences led her to avoid technology related learning opportunities altogether. Much of her technology-related learning was incidental because, if given the choice, she would not attend formal offerings. She explained, "If I stumble upon it or someone explains it to me one-on-one, I'm happy to adapt to that….But I will not go out of my way, myself, to look for things like that. I'm just not that interested." Because the learning culture at Dogwood High School was highly voluntary, it was easy for Karla to avoid professional development sessions, especially those related to technology-related learning. However, her willingness to adapt and try new things suggests an important consideration for technology leaders. Finding ways to "hook" teachers into learning technology might be especially important in schools with high numbers of reluctant learners. Teachers like Karla might need to stumble across new ideas repeatedly, in a variety of formats, before they begin to show interest in learning more. Experiences like those shared by Ashley, Karla, and James highlight the important role of context—including the physical context where teaching and learning occurs, as well as the workplace culture within a school building or district—in shaping teachers' professional learning.

The Role of Context

Recall from Chapter 2 that context refers not only to the physical location where learning takes place (Putnam & Borko, 2000), but also the inherent learning culture unique to each workplace (Webster-Wright, 2009). Researchers have previously established, across a variety of grade levels, geographical settings, and physical spaces, that context plays an important role in teacher learning (Jurasaite-Harbison & Rex, 2013; Kyndt, Gijbels, Grosemans, & Donche, 2016; Lohman, 2006; Marsick et al., 2014; Opfer & Pedder, 2011). Throughout my conversations with teachers, the impact of their teaching context on their technology-related learning was a prevalent theme.

Physical context. Context refers, in part, to the physical space where learning happens (Putnam & Borko, 2000). In the case of educational technology, this physical space could, in some cases, be a barrier to teachers' learning. Consider that Susan, the middle school CTE teacher, had ongoing installation problems with her new 3-D printer throughout the course of my study. In Susan's case, the technology itself was too large to make learning at home practical—she was bound to a specific physical context for her learning and had to wait until students left each day before she could continue troubleshooting the problem. She did not have access to her classroom on the weekends, so the problem lingered while she found time to work on it a few minutes each week. Ashley, the high school math teacher, shared a similar frustration with learning to use her new interactive whiteboard. It was impractical to take the technology home with her, so she was faced with spending additional hours in her classroom to teach herself the technology or continuing to underutilize the technology.

Somewhat contrary to my research related to the significance of "where learning takes place," teachers in my study did not attribute any particular significance to the location where they learned (cf. Levenberg & Caspi, 2010; Putnam & Borko, 2000). When I asked her about where she typically learned about technology, Karla replied, "That's like asking, 'Where do people fall in love?' It can happen anywhere!" Other participants agreed, sharing anecdotes of learning at lunch with colleagues, in the hallway, at home, at workshops and conferences, and in places completely separated from their professional contexts.

Workplace culture. Recall from Chapter 2 that previous researchers have found that workplace cultures that are supportive and collaborative support teachers' informal learning (E. Wilson & Demetriou, 2007). This was evident early on in my talks with Ashley, who had only taught in Dogwood Public Schools for 2 years; she had previous experience in a different school district and drew frequent comparisons between the two teaching contexts. Ashley reflected that her technology learning style had changed since coming to her current school:

> In the school I taught at previously, there were a lot of resources as far as colleagues that I could go to and ask more about using my SmartBoard or Dropbox or Google Drive or turnitin.com….That's where I learned most of [the technology].

Ashley also shared that in her current school she sometimes avoided using new technology, or used it in different ways, because she did not think her students were ready for more advanced integration of technology. For Ashley (and other teachers in my study), her technology-related learning was a function of her teaching context. She

adapted her learning to the resources available to her as well as to her students' needs and prior knowledge. In her previous context, her learning needs were different, in part, because her students' needs and prior knowledge were different. Therefore, context includes student needs, teacher learning preferences, and school culture. Context is multi-faceted.

James, the elementary school TAG teacher, had to find ways to fit his technology-related learning in wherever he could; in part, this was because his students acquired new technology skills at a faster pace than he could keep up with. Because his students moved at such a fast pace, the pressure was higher on James to prioritize his own learning. This was a function of his context. Whereas Ashley did not prioritize her own professional learning because other duties seemed more pressing, James's curriculum relied on constantly challenging his students, so his own learning became more important. Additionally, the classroom culture he created valued students' independent work. This protected time for him to dedicate to his own learning. The pressure was especially high for James because he was in the rare situation of being the only teacher of his subject area and grade level. He also attended very few collegial meetings because of his unique course load. His context forced him to learn with, alongside, and from his students relatively more frequently than other teachers in my study. However, because of the flexibility offered by informal and incidental learning pathways, James found a way to make learning possible in his unique context.

School district context. The implicit expectations related to teacher learning in this district were a further facet of context. As alluded to in previous sections, district leaders tended to give teachers broad autonomy for teaching and professional learning.

The majority of formal professional development offerings, such as weekly sessions led by the TSTs were voluntary. For James, this autonomy was a positive. He shared,

> I think I have the best job in the city…. They don't leave me alone, but almost anything I could [think to] do with the kids, if I thought there was value in it, [they would support me]. It's a really neat place to work.

For other teachers in my study, the lack of accountability was sometimes a challenge. Ashley reflected that, perhaps with more required technology training, teachers who were resistant to integrating technology would start to feel more comfortable and continue their learning afterward. This idea is supported by previous researchers (W. M. Jones & Dexter, 2014; Richter et al., 2011), who concluded that effective teacher learning might require at least some level of accountability. Celeste, the primary school teacher, mirrored this conclusion. She noted that there were many available resources she had not ever looked at, such as online tutorials created by the TSTs. In part, she attributed her reluctance to the idea that using the tutorials was voluntary: "There's been no set requirement. I mean, they're uploaded, so I'm sure they want you to look at them because that's going to help you get the best out of your Chromebook, but there's been no accountability piece." For Celeste, some level of accountability would have encouraged her to engage in more technology-related learning. Previous researchers have noted similar findings. Mouza (2002) found that administrative support was a key factor in effective technology professional development, even when teachers were engaged in informal learning activities.

Teachers in my study also reflected on the ways that the school district context sometimes limited their technology-related learning. Celeste and Brianna, the special

education teacher, both shared that the relatively small size of the school district led to limited access to new technology, including online subscription-based services. Brianna said, "It's kind of hard for us to get our hands on it sometimes. It's becoming more available, but we're such a small district that we're kind of behind the times in some ways." It is important to note that these teachers' perceptions of the level of technology availability might have been related to their long tenure in Dogwood Public Schools. Recall that the Dogwood Teaching Innovation Foundation supported many technology purchases in the district, and Celeste, Brianna, James, and Susan had each benefited from grants the Foundation awarded them. It is possible that teachers in neighboring districts did not share Celeste and Brianna's perception that Dogwood Public Schools had limited access to technology. On the other hand, Ashley, the high school math teacher, compared Dogwood Public Schools to her previous school district and, similar to Celeste and Brianna, felt her opportunities to learn new technology were somewhat limited. Similarly, Melissa, the high school CTE teacher and administrator, felt that the formal professional learning opportunities that were offered rarely fit her learning needs.

It is also interesting to note that the three high school teachers in my study (Karla, Ashley, and Melissa) worked in a building that was piloting a Bring Your Own Device (BYOD) initiative. Yet, despite the ready availability of students' mobile devices, which increased the opportunities to learn with and from their students, Ashley and Karla reported only minimal changes in their technology-related learning related to BYOD; Melissa reported none. It is possible that, as the BYOD program moves beyond its pilot year and into full implementation, its impact on teachers' technology-related learning will

increase. However, it was surprising to me that the informal and incidental learning experiences teachers shared seemed largely unaffected by this contextual element.

Despite being employed by the same, relatively small school district, the seven teachers in my study worked and learned in diverse contexts. Each teacher had a unique physical classroom context, with slightly different available classroom technologies. Likewise, each school within the district had a unique workplace culture, with slightly different norms and values associated with technology-related learning. These differences, combined with the inherent differences in the teachers' learning preferences, resulted in a variety of learning needs. Considerations of the many pathways along which teachers learn about technology, as well as teachers' distinct learning preferences and the unique contexts in which they teach and learn, point to a need for differentiated formal supports for their informal and incidental technology-related learning. The types and levels of formal supports required for teachers to maximize their technology-related learning seemed, in my study, to be heavily dependent on the contexts in which they taught.

Formal Supports for Informal and Incidental Learning

Recall from Chapter 2 that some researchers have suggested that formal structures and supports might help teachers capitalize on the benefits of informal learning (Hoekstra & Korthagen, 2011; W. M. Jones & Dexter, 2014; Tarc, 2007). There is also some evidence that increasing formal professional development offerings related to technology might, in turn, increase teachers' engagement in informal and exploratory learning related to technology (Dexter, Barton, Morgan, & Meyer, 2016). This further bolsters the idea that schools should encourage teacher learning along many pathways.

Dexter and colleagues (2016) have also suggested that school leaders' formal supports for teacher learning, such as establishing a culture of collaboration and modeling reflective teaching practices, could increase the value of teachers' informal learning experiences. O'Hara and colleagues (2013) reported that teachers felt most confident integrating technology in the classroom when they learned along formal and informal pathways and were supported by tech-savvy colleagues. Researchers have also noted teachers' tendency to prioritize other work responsibilities over their own professional learning (Hoekstra et al., 2007). These potential barriers to teachers' technology-related learning—lack of a collaborative learning culture, avoidance of technology-related professional learning, and scarcity of informal technology mentors—might be mitigated by the provision of formal supports for teachers' informal and incidental technology-related learning.

Unstructured time with colleagues. An important formal support for teachers' informal and incidental technology-related learning might be protected, unstructured time with their colleagues. Kyndt and colleagues (Kyndt et al., 2016) conducted a systematic review of 74 studies of teachers' informal learning and concluded that "nonteaching time with colleagues" was an important antecedent for teachers' informal learning. This unstructured time might allow teachers to develop a more collaborative culture for all types of professional learning, including technology-related learning. This was true for teachers in my study. For example, when I asked about where her informal and incidental technology-related learning happened, Celeste, the primary school teacher, shared that,

> A lot of it happens like at lunch when we're just talking about what we've done or a lesson that went really well. And we're sharing with each other because we all

eat at the same time. It [also] happens during common planning time; we meet once a week.

Common lunch and planning times are an example of a formal support Celeste's informal and incidental learning. Another type of formal support for unstructured collaboration could be release time for teachers to observe and network with colleagues. Susan, the middle school CTE teacher, shared, "A couple of years ago, I got the opportunity to take time off from school and I visited other middle schools in the local area and I compared my curriculum to their curriculum." This experience introduced Susan to several new technologies, as well as new uses for technologies she already had. Further, it expanded her professional network. The colleagues she met and worked with during this observation experience also attended the same professional conference as Susan, so she continued to network with them beyond her one-day visit to their schools. For the teachers in my study, informal and incidental technology-related learning flourished when they were given unstructured time to collaborate and converse with colleagues.

Technology Support Teachers (TSTs). One type of formal support for teachers' informal and incidental technology-related learning, and one that was particularly strong in Dogwood Public Schools, might be strategic use of tech-savvy personnel. The TSTs in Dogwood Public Schools provided myriad formal supports for teachers' informal and incidental learning about technology integration. For example Melissa shared, "Our TSTs offer technology workshops in various dates and times to accommodate teachers' schedules. They also create YouTube lessons." Melissa appreciated this follow-up support and felt it extended her learning. Melissa's experience mirrors findings from Hastie and colleagues (2015) in their multiple-case study of teachers from Ireland, Spain,

and Taiwan. The researchers found that teachers in their study needed access to tech-savvy colleagues after formal training sessions had ended in order to capitalize on the benefits of the formal learning sessions.

Teachers in my study reported that the TSTs also supported their hands-on technology-related learning. Susan shared,

> If I have [technology] I want to learn…. I can send an inquiry to the TSTs. And they're awesome people because they know lots of stuff. They will inquire and learn about it and let me know—call me or email me—and then I can sit down with them and we can do some of it together. So the TSTs are a big help.

Recall from a previous section that Susan, like other teachers in my study, had a strong personal preference for one-on-one help. The TSTs' willingness to help her in her preferred learning mode greatly increased the amount of technology-related learning Susan engaged in. Susan also shared an example of the middle school TST helping her find grants to apply for so she could purchase a new 3-D printer. This led, indirectly, to Susan's ongoing learning about a new type of technology that would have been financially out of reach without the TST's encouragement and help with the grant application.

The TSTs in Dogwood Public Schools provided support for teachers' learning in more subtle ways as well. They gave the teachers in my study permission to learn along unstructured pathways, legitimizing and validating teachers' informal and incidental learning. For example, Celeste, the primary school teacher, remembered a TST who she worked with earlier in her teaching career:

> I had a TST probably 10 years ago. She really released me because she said, "You're not going to break it. Explore. Click on things. Figure out what things are. Try things. You're not going to break it." That was very liberating for me. So I just started doing it; I just started clicking on things and figuring things out.

Celeste described this as a watershed moment in her professional learning. Prior to this conversation, she had felt fear about exploring technology—it was new to her, it was expensive, and she felt unsure of herself whenever she interacted with it. The TST empowered her to learn in her preferred style, by exploring the technology and "just clicking on things." Now, she shared, she does it all the time.

Layers of support. Formal support for teachers' informal and incidental learning about technology integration is layered. On the most basic level, formal support might look like installing software and enrolling students in online, subscription-based services. Ashley, James, Susan, Melissa, and Celeste referenced the importance of a TST installing software or enrolling students in a subscription-based service. This type of formal support might be overlooked or taken for granted, but it is critical for teachers' technology professional learning. If software is not installed, teachers cannot learn to use it. Similarly, if students are not enrolled in a paid service, this creates a barrier to teacher learning.

A middle layer of formal support might be the direct support tech-savvy personnel provide to teachers: personalizing professional learning materials to appeal to a variety of teacher learning preferences, showing teachers how to use new technology, and co-teaching lessons with tech-wary teachers. All of the teachers in my study shared experiences of learning in these ways from informal technology mentors, including the

district's TSTs. As discussed in previous sections, this middle layer of support also helped personalize learning for the teachers in my study, giving them the just in time and just right levels of support they needed. Here, it is important to note that the TSTs in my study had the trust and support, not only of the school leaders in the buildings where they worked, but also of Dogwood Public Schools' district leaders. The TSTs were given broad autonomy to set their own rotational schedules and develop professional development materials suited to the learning needs and preferences of the teachers in their schools. Further, the TSTs were protected, at both the building and district levels, from responding to basic troubleshooting or technology support requests—instead, teachers were encouraged to forward these types of problems to IT personnel. This allowed the TSTs more time to work alongside teachers, differentiate the supports they provided, and establish strong working relationships with teachers across the district.

At the highest level of support for professional learning, as in Celeste's example of feeling empowered by a conversation with a former TST, formal supports form the foundation for other types of technology-related learning. Informal learning, in particular, requires this foundation: when teachers need to learn, they need established structures, pathways, and resources, where they can track down the information in the moment or shortly after the learning need arises. In some cases, this highest level of formal support might also be more directive in order to push teachers beyond their comfort zones and help them protect time for their own professional learning. Ashley, the high school math teacher, reflected,

> I think if it came from the top down, it would be shown why it works and examples of it and was pushed a little harder, that would help all aspects. It would

help the younger teachers, new teachers; it would help the veteran teachers if they would listen to it. It would help grow our technology skills.

At schools like Dogwood High School in particular, where the majority of teachers are veterans and there is a cultural resistance to change, some compulsory professional development might be required to get innovation started. School and district leaders are uniquely positioned to communicate and enforce these expectations, when necessary, since technology leaders often do not have the positional authority to require teachers' attendance at professional development sessions. Once teachers have a baseline understanding of a new technology, their technology-related learning could proceed along the many pathways evidenced in other schools in the study. The types and levels of formal support required for teachers to maximize their technology-related learning seem to be heavily dependent on the contexts in which they teach. District, school, and technology leaders should work together to find the best combination of supports for the unique contexts in which they work.

The Phenomenon of Teachers' Informal & Incidental Technology-Related Learning

After looking across the lived experiences of the teachers in my study, there are several tentative conclusions I can make related to the phenomenon of teachers' informal and incidental learning related to technology integration. Some of these tentative conclusions are consistent with and supported by extant literature, as presented in Chapter 2 earlier in this chapter. However, others bear further scrutiny, as they have not been thoroughly examined by previous researchers. At best, they should be viewed as working hypotheses, in need of further research and investigation. In this final section of Chapter 5, I present an overview of my tentative conclusions. In Chapter 6, I will

consider the implications of each, making recommendations for school, district, and technology leaders relative to these findings.

First, my analysis suggests that informal and incidental technology-related learning happens frequently, across grade levels, content areas, and teaching contexts. As one teacher in my study shared, "That's like asking 'Where do people fall in love?' [Informal and incidental learning] can happen anywhere." Teachers do learn about technology along formal pathways, but this learning is rarely isolated from their learning along informal and incidental pathways. In other words, teachers' learning about technology integration happens along many pathways—formal and informal—regardless of where and how learning originates. This conclusion has a basis in the extant literature: Collinson and Cook (2004) found that sharing technology integration knowledge "tended to be informal, specific, and exchanged in small doses" (p. 130); Smaller (2005) concluded that nearly 90% of the 500 teachers in his study learned about technology informally; Williams and colleagues (2014) noted that 75% of agriculture teachers in their study reported that a majority of their technology learning was informal or incidental learning.

Second, informal and incidental technology-related learning seems to be sensitive to the pressures of time. It is threatened by limitations on teachers' time. If teachers do not apply new technology-related learning quickly, they tend to lose the learning. If teachers have a technology-related learning need and it is not addressed in a timely manner, the need tends to pass and their learning is neglected. Again, these tentative conclusions are supported, in part, by extant research. Previous researchers have noted that teachers' technology-related learning requires adequate time for hands-on practice

(Matteson et al., 2013; Mouza, 2002; J. G. Wells, 2007); that "saving it for later" might result in loss of technology-related learning and skills (Aubusson et al., 2009; Hiltz, 2015); and that "just-in-time" supports are critical for technology-related learning (W. M. Jones & Dexter, 2014; Mouza, 2002). Further, the Office of Educational Technology and the U.S. Department of Education (2016) have recommended "continuous, just-in-time support that includes professional development, mentors, and informal collaborations" (p. 25) to help teachers integrate technology successfully.

Third, informal and incidental technology-related learning appears to be fostered by formal, organizational supports. Formal supports for informal learning are important because they mitigate potential barriers to teachers' technology-related learning, like lack of a collaborative learning culture, avoidance of technology-related professional learning, and scarcity of informal technology mentors. Previous research also supports this conclusion (Dexter et al., 2016; Hoekstra et al., 2007; O'Hara et al., 2013; Zhao & Bryant, 2003). These supports, initiated and maintained by school, district, and technology leaders, should be layered and tailored to the unique contexts in which they are applied because of factors like the inherent diversity in teachers' classroom contexts, available classroom technologies, workplace cultures associated with technology-related learning, and teachers' learning needs and preferences.

Fourth, informal and incidental technology-related learning is seemingly heavily influenced by teaching contexts. Context is multi-faceted and includes considerations of physical teaching space, students' learning needs, teachers' learning preferences, and school culture. Elements of context related to technology-related learning involve the mobility of a technological tool (i.e., Can it be taken home for the weekend?); the level of

collegial support for technology-related learning (i.e., Are there other teachers I can ask questions about this new technology?); students' prior technology knowledge (i.e., Are my students ready to learn a new technology?); and district expectations related to technology-related learning (i.e., Does the district expect or require me to integrate this technology in the classroom?). The impact of context on teacher learning is well established in extant literature (e.g., Jurasaite-Harbison & Rex, 2013; Kyndt et al., 2016; Lohman, 2006; Marsick et al., 2014; Opfer & Pedder, 2011). However, little previous research has examined the potential role of context on teachers' informal and incidental technology-related learning.

Finally, informal and incidental technology-related learning appears to be driven by teachers' learning preferences. This is a new finding that future researchers could explore in greater depth, especially because teachers' learning preferences might inhibit their technology-related learning, causing them to avoid certain potentially valuable learning pathways. In my study, for example, Karla—who described herself as "an enemy of technology"—avoided professional learning opportunities related to technology because she found them irrelevant and uninteresting. However, teachers in my study who were extremely tech-savvy, like James and Melissa, also avoided professional learning opportunities related to technology—because the opportunities did not align with their learning needs and preferences. At both ends of the spectrum, from technology-avoidant to technology-savvy, teachers' learning preferences influenced their engagement in future technology-related professional learning opportunities. In Chapter 6, I will discuss possible implications and recommendations regarding this finding, as well as the previously discussed results, in further detail.

Chapter 6: Implications

The purpose of this study was to understand more deeply the phenomenon of teachers' informal and incidental learning related to technology integration. Through interviews, observations, and surveys, the seven teachers in my study revealed the many, varied ways they learned to integrate technology; I have referred to these as *learning pathways* throughout the preceding chapters. In Chapter 5, I analyzed what teachers shared with me, looking across their individual experiences to draw tentative conclusions about what their collective experiences revealed about the phenomenon of informal and incidental technology-related learning. I situated those tentative conclusions within relevant extant literature. In Chapter 6, I look beyond the experiences of the teachers in my study to address what my findings might mean for educational leaders at the school and district level, as well as those in positions of educational technology leadership.

As school, district, and technology leaders seek to improve teachers' technology-related learning, it might be useful for them to adopt a mindset that values professional learning along informal and incidental pathways and views teachers not as students, but rather as adult learners. Related to these ideas—valuing many types of professional learning and treating teachers as adult learners—Drago-Severson (2016) has recommended school leaders subscribe to "four pillar practices for growth" (p. 72). Namely, these are: *teaming*, *providing leadership roles*, allowing for *collegial inquiry*, and *mentoring*. Note that teaming, which encourages teachers to work together to solve

problems of practice; collegial inquiry, which provides teachers time and space to collaborate and explore; and mentoring, such as that provided by informal technology mentors, are consistent with findings from my study as well and the work of researchers I have shared throughout this document. Drago-Severson (2016) expands on each of these ideas, recommending specific formal supports that foster these practices. For example, school and district leaders can foster teachers' learning through teaming by providing conversational guidelines, procedures, and goal-setting guidance to structure the informal conversations teams have, as well as the time and space to have these informal conversations. And collegial inquiry is encouraged when leaders urge teachers to engage in self-reflection and share these reflections with their colleagues for the purpose of improving practice.

Many school and district leaders might have to make a conscious effort to shift mindsets in order to view teachers as adult learners; for some technology leaders, in particular, viewing teachers as adult learners might be a small but significant shift in perspectives. Consider that the Technology Support Teachers (TSTs) in my study began their careers as classroom teachers. For technology leaders like these TSTs, who have a background in educating students directly, it is important that they refine their teaching approach when working with adult learners instead of students. Relevant extant research suggests that this shift might provide valuable improvements in terms of teachers' professional learning. The field of adult learning, or *andragogy*, is far-reaching and well researched (e.g., Knowles, 1980) and my recommendations in this chapter will present only a limited slice of the rich base of literature related to this field. There are several

parallels between andragogy and teachers' informal and incidental learning that have bearing on the current discussion.

Writing about adults as learners, Trotter (2006) asserted that teachers should be allowed the flexibility to determine their own programs of professional development, including collaborating with colleagues and learning from informal mentors. Similarly, Terehoff (2002) has recommended that principals should think of teachers as adult learners, not students, designing professional development that provides a variety of opportunities for teachers to learn independently, rather than following a rigid curriculum. Other researchers have also encouraged school leaders to view teachers' learning from the perspective of adult learning theory (e.g., Beavers, 2009; King, 2002; Lawler, 2003). Specifically, Lawler (2003) has proposed several recommendations to guide those who work with adults as learners. Teachers of adults should:

- Create a respectful climate that is personalized to adults' learning styles and learning needs.
- Respect adult learners' professional expertise by eliciting their active participation in learning activities.
- Provide adult learners with immediate opportunities for relevant hands-on practice. (pp. 17–19)

Recall from Chapter 5 that many of these recommendations align with technology-related learning experiences the teachers in my study shared and are consistent with other, relevant extant research. Teachers in my study learned about technology along multiple pathways; they learned through collaboration with colleagues and informal technology mentors; they expressed a desire for personalized learning; and they appreciated

opportunities to apply what they had learned through hands-on activities. In the following sections, I will examine these suggestions more closely, making recommendations for school and district leaders, as well as educational technology leaders and decision-makers, and situating these recommendations within relevant extant literature.

And*, Not *Or

Educational leaders should develop a system of technology supports that is rich with opportunities for teachers to learn along formal, informal, and incidental pathways, and through a variety of approaches along each pathway. Similar to the layers of formal supports I suggested in Chapter 5, school, district, and technology leaders should work together to develop comprehensive, personalized, context-driven formal supports for teachers' technology-related learning. Lai (2011) has suggested that informal and formal learning have a reciprocal relationship (p. 1270). That is, teachers might use informal learning experiences to make meaning from, extend, or enhance their formal learning experiences. Similarly, Vu (2015) concluded that technology integration training should include both formal and informal learning opportunities. Teachers might encounter technology-related learning informally or incidentally, and then build on that learning along formal pathways. The types of learning—formal as well as informal and incidental—should be valued equally, with teachers-as-adult-learners encouraged to choose their preferred pathways for technology-related learning. In some cases, this value might come in the form of recertification points, with school and district leaders providing "credit" for teachers' independent and informal exploration of technology, for example. Further, as changes occur with specific technologies, contextual considerations,

teachers' learning goals and preferences, and students' learning needs, teachers should be encouraged to continue choosing appropriate learning pathways.

For the teachers in my study, technology-related learning was evolutionary. For example, it might have started with attending a formal presentation, but it then progressed through talks with peers and colleagues, reading print and digital texts, and exploring the technology by "just clicking on things." Educational leaders should be cognizant of this type of learning progression and avoid one-size-fits-all or one-time-only approaches. Plans for professional development related to technology should be differentiated, not only according to learners' needs and preferences, but also by the phase of technology adoption; learning needs during initial implementation will likely be different than those that emerge years into a new technology-related initiative (Ramirez, 2011). Ramirez (2011) has emphasized that it is incumbent on school and district leaders to ensure that the appropriate financial and human resources are in place to make this kind of sustained support feasible. The teachers in my study expressed a need for layers of ongoing learning opportunities: for example, watching a video and reading a reference guide (like James, the elementary TAG teacher), or attending a conference session and talking with colleagues after the session (like Susan, the middle school CTE teacher). There is support for this concept in previous research. Hiltz (2015) wrote,

> Schools may more effectively reach a greater number of staff members by providing a mixture of approaches for each tool or technology initiative including providing online independent explorations using [self-directed learning] SDL principles and also providing more traditional facilitator-led sessions. (p. 3206)

Again, the focus for educational leaders should be providing multiple layers of learning opportunities for teachers to choose from. In Hiltz's (2015) example, technology-related professional learning would combine "traditional facilitator-led sessions" (i.e., formal learning opportunities) with "online independent explorations" (i.e., informal learning opportunities). The teachers in my study shared that they were already learning this way, combining modes of learning along formal, informal, and incidental pathways to integrate technology effectively. Educational leaders should capitalize on this natural tendency, designing professional learning programs accordingly.

In isolation, both formal and informal learning pathways have limitations. Ignoring these limitations might come at the expense of optimal professional learning for teachers. Recall from Chapter 2 that formal professional learning is often limited by a one-size-fits-all approach (Eraut, 2004) or lack of funding to implement high quality, ongoing, job-embedded programs (Garet et al., 2001). Yet, informal and incidental learning opportunities also have limitations. They rely on teachers who are motivated to extend their learning voluntarily (Marklund, 2015) and who will prioritize their professional learning over other teaching responsibilities (Hoekstra et al., 2007). The best approach to teachers' professional learning related to technology integration might be a combined approach—one that recognizes, values, and relies on formal, informal, and incidental pathways. This echoes guidance from W. M. Jones and Dexter (2016):

> What organizations lose by focusing primarily on formal learning activities is the opportunity to build on their initial investment in a teacher's learning experience. Given the challenge of implementing high-quality teacher learning environments

> with continuous, situated, and social learning, it stands to reason that exploring all opportunities to expand organizational supports is warranted. (p. 265)

When educational leaders acknowledge that teacher learning happens along a variety of pathways, they might be less likely to neglect one type of learning (e.g., informal learning opportunities) in favor of others (e.g., formal professional development activities).

Other researchers have offered similar recommendations. Beavers (2009) suggested that school leaders design professional development for teachers with choices about when, where, and how they learn (p. 28). Similarly, Melber and Cox-Petersen (2005) surveyed 54 science teachers who participated in one of three professional development programs. Teachers in the study reported that a combination of formal, classroom professional development and informal, hands-on learning experiences—via fieldwork or museum learning—was most effective for their professional learning. The teachers also retained the knowledge long-term, reporting that they were still applying learning from this experience 2 years later (Melber & Cox-Petersen, 2005). Recall from Chapter 5 that teachers in my study often continued to learn in informal and incidental ways long after learning from formal presentations, like Brianna who was still "clicking around" to learn more about the Boardmaker software 7 years after her first formal training session. Educational leaders should plan for teacher learning along several, overlapping and ongoing pathways.

It is also important for technology leaders, in particular, to consider the variety of ways teachers learn and the variety of ways leaders can support that learning. For example, as more schools "go paperless" and transition to online, cloud-based storage of materials, it might be important to consider teachers, like Karla and Susan in my study,

who prefer to read from paper rather than a screen. When developing materials to support teachers' technology-related learning—tutorials, guides, and presentations—technology leaders should take care to include options. Rather than thinking in terms of *or* (e.g., Should I schedule a formal presentation or send emailed instructions?), leaders should think in terms of *and* (e.g., How can I ensure teachers who want to learn shoulder-to-shoulder and teachers who want to learn independently both have access to this learning opportunity?). An overreliance on one mode of teacher learning is unlikely to serve all—or even most—teachers. Rather, whenever possible, learning opportunities should be personalized to teachers' learning styles and needs (Lawler, 2003). It is likely that, for each new technological tool or software, different teachers will learn in different ways, dependent on their different contexts, learning preferences, and relevant prior knowledge.

The idea of offering teachers many opportunities to learn extends to the organizational level. Leaders at the school and district levels should work closely with technology leaders to develop layers of organizational supports for teachers' technology-related learning. District leaders should carefully develop a strategic plan for technology that is aligned with the district's instructional strategic plan and includes plans for technology-related professional development (e.g., Ramirez, 2011). School leaders should understand and follow that plan, thinking about the ways it might need to be adapted to their specific contexts (Ensminger & Surry, 2008) and supporting the personnel who are working to implement the plan at the classroom level, like the TSTs in my study. Finally, technology leaders should implement the plan in a differentiated, individualized manner, according to teachers' learning needs and preferences. Formal

supports for teachers' technology-related learning should be coordinated throughout the system.

Considerations of Context

School leaders who make decisions about technology and technology-related professional development should work to create contexts that support teachers' learning across the spectrum from informal to formal. Specifically, educational leaders should consider which combinations of formal supports are best suited for teachers' learning needs and preferences, based on the technologies being introduced and the unique contexts in which they are being introduced. In fact, previous researchers have suggested that the success of educational technologies is highly context-dependent (Ensminger & Surry, 2008), and that leaders should consider technology integration from a systems-thinking perspective (Schrum & Levin, 2016), acknowledging contextual elements at the classroom, school, and district levels, rather than in isolation. This consideration includes planning around such contextual elements as the level of teachers' prior knowledge related to the technological tool or software being introduced (i.e., classroom level); the degree of collegial support for learning available to teachers in the school (i.e., school level); the extent to which other teachers in a school will be learning, concurrently, to use the same or different technologies (i.e., school and district levels); whether there are organizational impediments to technology-related learning that the technology leader could remove or mitigate (i.e., classroom, school, and district levels); and the potential benefits to students and teachers afforded by the new technology (i.e., classroom, school, and district levels). In the following sections, I explore each of these contextual elements in greater detail.

Recall from Chapter 2 that merely creating access to technology does not necessarily lead to technology integration (Cuban et al., 2001). Just as school leaders should take care to provide multiple pathways for teachers to learn about technology, they should also acknowledge that teacher learning is situated within unique contexts. For example, Schlager and Fusco (2004) have cautioned against the tendency of some school-level leaders to focus energy into developing online communities of practice at the expense of supporting the in-person learning community within a school. They argue that teachers need both types of access and support—online and in-person—for optimal learning. Schlager and Fusco (2004) wrote,

> Formal professional development programs represent a form of experimentation leading to discovery of how to improve instruction. But if that and other forms of experimentation and innovation remain disconnected from the larger learning context—the norms and practices of the collective community—then the system will not improve. (p. 30)

Educational leaders at the school level are uniquely positioned to establish and support norms and practices that lead to a culture of collaboration among teachers. Anderson and Dexter (2005) have also suggested that school leaders take an active role in technology-related learning, modeling their own technology-related learning and communicating explicit expectations about the ways teachers use and learn about classroom technologies. These recommendations are supported by other researchers as well (e.g., Ramirez, 2011; Schrum & Levin, 2016). School leaders should also empower technology leaders within their buildings to support teachers' technology-related learning in a variety of ways. In my study, the TSTs—with support from school- and district-level administrators—had

established a norm of collaborating closely with teachers to support their professional learning related to technology; all seven teachers in my study shared examples of times this had happened for them.

School-based technology leaders, like the TSTs in my study, might be uniquely positioned to provide support that is tailored to each teacher's prior knowledge, learning needs and preferences, and context. For example, when James needed help planning an advanced robotics activity, he collaborated with a TST to write a grant application and plan the activity. When Susan wanted a new way to engage students in learning about physics, a TST mentioned flight-simulator software, and then worked shoulder-to-shoulder with Susan to teach her how to use it. And when Karla had forgotten how to create a report with the district's gradebook software, the high school's TST stopped by her room and showed her how—in German. Although I certainly stop short of recommending that technology leaders learn a new language to support teachers' technology-related learning, school-based technology leaders can and should focus on providing appropriately personalized formal, organizational supports for teachers' technology-related learning, including consideration of teachers' contexts. School and district leaders, in turn, should support technology leaders' ability to provide these types of support for teachers, by encouraging collaboration between technology leaders and teachers and by protecting the time required to develop collaborative relationships between technology leaders and teachers (e.g., Drago-Severson, 2016), like those that emerged in my study.

Teachers' prior knowledge. Formal supports for teachers' informal and incidental learning might be especially critical when integrating a new educational

technology that does not naturally build on teachers' prior knowledge. Recall from Chapter 2 that when technology is new, teachers might be forced to rely more heavily on informal and incidental learning pathways (e.g., Kessler, 2007). Consider the example of Celeste, the primary school teacher in my study. Her school installed interactive whiteboards for every teacher, with no clear plan for formally training teachers how to use the new technology. Most of the teachers in the school had no prior experience with interactive whiteboards, and Celeste shared that they initially felt overwhelmed by the task of learning to integrate the new technology into instruction. In the end, teachers explored and learned with and from their colleagues, but Celeste's experience highlights an important consideration for educational leaders. When the learning curve for a new technological tool is steep, teachers will likely need to rely on their informal and incidental interactions with peers and colleagues to hone their learning—but having a common starting point or foundation for that learning might make those informal and incidental learning experiences more effective.

In some cases, formal professional development might be a necessary foundation for teachers' continued, informal exploration and learning. Celeste explained that the introduction of the interactive whiteboards was a very stressful time in her teaching career and that she wished the schools' TSTs had provided some level of formal training at the time the boards were installed. Because no formal training was offered, teachers were forced to learn *only* through informal and incidental pathways, exploring the new technology independently and talking with colleagues about what they discovered. When planning their approach to introducing a new technological tool, technology leaders should consider whether teachers have prior experience with similar technological tools

and the degree of formal training that might be necessary as a foundation for teachers' ongoing informal and incidental learning. In turn, school and district leaders should take care to hire qualified technology leaders whose advice they can trust in making these decisions.

Collegial support for learning. Leaders must also be aware of the limitations of specific contexts in terms of opportunities for teachers to collaborate with colleagues. This type of informal and incidental learning was important to all of the teachers in my study. Yet, several participating teachers felt relatively isolated from peers and colleagues. In some school districts, particularly those that are small, rural, or piloting new technologies, technology leaders might need to facilitate connections with teachers in other school districts to provide teachers with adequate networking opportunities. Researchers have found that valuable informal technology learning can happen through online collaboration (Voogt, 2010; Wesely, 2013). Even within schools, one type of formal support could be classroom proximity: some researchers have recommended deliberately pairing tech-resistant teachers with tech-savvy teachers (e.g., Glazer et al., 2005). This has the potential to increase the opportunity for—at a minimum—incidental learning between the two teachers.

Although school, district, and technology leaders should support teachers' collaboration in technology-related learning, collegiality should not be forced upon teachers (Clement & Vandenberghe, 2000). The many examples presented in Chapter 2 of inauthentic, manufactured communities of practice (e.g., Bilodeau & Carson, 2015; Britt & Paulus, 2016; Mak & Pun, 2015; Murugaiah et al., 2012; Stein & Coburn, 2008), as well as feedback from teachers in my study, suggest that forced collaboration between

teachers is rarely an effective pathway for teacher learning. Instead, leaders should focus on developing a context where collaboration happens naturally and there are many opportunities for teachers to collaborate around technology. For example, after a formal technology-related training event, leaders might consider providing stations for teachers to explore the new technology hands-on, in small, self-selected groups. This way, time for learning is deliberately protected and teachers' informal and incidental learning could continue, building on the information presented in the formal training.

Educational leaders might also consider the ways in which extant collegial groupings of teachers could be leveraged for the purposes of technology-related learning. For example, the teachers in my study who worked in schools with Professional Learning Communities (PLCs) (i.e., Celeste, Brianna, and James) did not report substantial technology-related learning within PLCs. However, Celeste and Brianna did report substantial technology-related learning from their colleagues in the school. Brianna, the special education teacher, had even joined an informal special education PLC that sometimes focused on technology-related learning. These teachers' contexts included a high degree of collegial support for learning. In contrast to the other teachers in my study (most of whom worked in schools without active PLCs), Celeste and Brianna, especially, shared more examples of learning from colleagues in their school. Yet most of their technology-related learning did not happen within PLCs. One strategy educational leaders might employ is capitalizing on extant groupings of teachers (e.g., grade-level teams or content-area departments), who have a pre-established level of collegiality. In this way, leaders might improve technology-related learning through existing channels, rather than creating new and inauthentic forced groupings or sequestering technology-

related learning outside of those extant groupings. Again, school and district leaders should work closely with trusted technology leaders to make these decisions.

Uniformity versus differentiation. Educational leaders should also carefully weigh the benefits of uniformity versus differentiation. Although it can be advantageous to allow teachers to adopt the technologies they feel most comfortable with, this piecemeal approach might also limit opportunities for teachers to support one another's learning. Consider two examples from my study: Ashley, the high school math teacher, was the only teacher in her school with one particular brand of interactive whiteboard. Even the TSTs could not help her learn to use it. In contrast, Celeste, the primary school teacher, was part of a school-wide adoption of interactive whiteboards, where every teacher received the same brand of device. Similar to Ashley, Celeste received no formal professional development related to using the interactive whiteboard. However, she and her fellow teachers explored the new technology together and independently, sharing ideas and collaborating to learn from one another informally. Ashley was unable to do this because no other teachers in her school had the same brand of device. These examples illustrate the larger point that, again, educational leaders should consider contextual factors related to types of available technology and the potential for informal collaboration between and among colleagues when planning learning opportunities for teachers. Ashley's experience, in particular, highlights the need for district-level leaders to develop, implement, and regularly evaluate and revise, a technology strategic plan. Such a plan would guide technology-purchasing decisions and include considerations related to teachers' technology-related professional learning.

Removing impediments to learning. One key organizational support for teachers' technology-related learning is removing technology-related impediments to learning. For example, learning aids should be platform-independent—some teachers prefer Mac and others use PCs, but the format of the learning material should work equally well on both systems. Teachers in my study like Karla and Ashley preferred to use their personal Mac laptop computers, but the school district relied on PCs. This meant that sometimes Karla and Ashley encountered problems transferring activities they had planned at home onto the school operating system. Likewise, some learning aids that had been developed by technology leaders at the school did not display correctly on these teachers' preferred devices. This was an impediment to learning that the school's technology leaders could easily have removed by creating resources that were platform-independent. Making teacher resources platform-independent has the added benefit that if technology platforms in the district change, materials that have been developed will remain useful.

Another way technology leaders, in particular, could remove impediments to teachers' learning is to allow teachers to anticipate or preview challenges they might encounter when trying a new technology or website with students. For example, technology leaders might give teachers the option of viewing the school network through a generic student account. Teachers in my study like James and Karla were frustrated when they found out that sites or resources they had bookmarked for student use were actually blocked on student accounts or displayed differently for students than they did for teachers. Although these teachers could request each individual block be removed, the difference in privileges between teacher and student accounts prevented in-the-moment

access to materials they had prepared and thwarted the teachers' further exploration of resources.

Benefits for students and teachers. Finally, the teachers in my study were more likely to integrate technology when they saw a clear benefit to their students or themselves. Even Karla, the most technology-resistant teacher in my study, was willing to try new technologies when students suggested them or when she recognized a potential benefit to student learning. This points to a need for educational leaders to emphasize the ways in which new technologies might benefit students in their unique contexts. Previous researchers have also identified this need (e.g., Beavers, 2009; Ottenbreit-Leftwich, Glazewski, Newby, & Ertmer, 2010). Rather than presenting technological tools as a panacea for educational obstacles, leaders should carefully consider the specific ways those technologies might help teachers and students. Technology leaders and other school administrators should also participate directly in these efforts. Researchers have suggested a need for principals to be directly involved in technology professional development programs, supporting teachers' learning (Mineo, Meier, & Seligson, 2011).

Learning Takes Time

For the teachers in my study, limited time for learning was a key concern. This suggests that one of the most important organizational supports school, district, and technology leaders can provide might be protected time for teachers' technology-related learning. In fact, each of the recommendations in the previous sections is contingent on adequate time for teachers' learning. Creating a variety of learning materials (i.e., focusing on *and*, not *or*) depends on teachers having time to use those materials. Building a context where collegiality is the norm and teachers naturally extend their formal

learning experiences along informal and incidental pathways relies on providing teachers time and proximity to interact with their colleagues during and after formal presentations. This recommendation is also supported by extant literature. Professional learning takes time—both time for learning and time for reflecting on what has been learned (Webster-Wright, 2009). Shea (2010) observed that limited time often prevented teachers from extending and deepening their learning through talking with colleagues. Other researchers have found that insufficient time for learning was a barrier that prevented teachers from even attempting to integrate technology in the classroom (Beeson, Journell, & Ayers, 2014; Cuban et al., 2001; Hew & Brush, 2006; Murugaiah et al., 2012) and that technology-related learning, in particular, required time for teachers to explore and "play" with new devices and software (Psiropoulos et al., 2016). Protecting time for teachers' technology-related learning might be the single most important step leaders can take.

Teachers need time to interact informally with their colleagues (Lohman, 2006). Unstructured time with colleagues is critical for teachers' ongoing professional learning (Knight, 2002; Shea, 2010). This might take the form of common subject-area or grade-level planning times; duty-free lunch periods and the provision of a shared space, like a staff workroom; or time within formal faculty meetings for informal collaboration (Lohman, 2000, 2006). Technology leaders, in particular, might also consider curating resources for teachers, such as helpful websites, webinars, videos, and printed texts. These curated resources, along with protected, unstructured time to learn with and from colleagues could allow teachers to capitalize on limited time efficiently and in the ways that best align with their learning needs and preferences. Again, these are some of the

same principles Lawler (2003) has suggested when designing learning experiences for adult learners. Additionally, recall from Chapter 2 that Hoekstra and colleagues (2007) found that teachers do not always prioritize their own learning when given free time, which was also true for teachers in my study. This underscores the importance of supporting efficient use of the limited resource of time and, in some cases, providing at least some formal supports that protect teachers' time for learning—including their informal and incidental learning. Technology leaders should work with other school and district leaders to outline specific professional learning expectations for teachers and to explicitly communicate the value of teachers' informal learning experiences. In certain contexts, a formal expectation or requirement that teachers spend unstructured time on professional learning, rather than grading papers or planning lessons, might be a necessary formal support. School and district leaders might further incentivize these learning pathways by offering recertification credit for teachers who demonstrate that they have used planning time for professional learning, even along informal pathways.

Considerations of time might be especially significant if technology is place-bound. Two teachers in my study—Ashley, the high school math teacher, and Susan, the middle school Career and Technical Education (CTE) teacher—encountered this impediment to their technology-related learning. Recall from the previous section that Ashley had a new interactive whiteboard that she was eager to incorporate into instruction; however, since she had to be physically in her classroom to explore it, she had not found the free time to learn much about using it. Similarly, Susan was troubleshooting problems with a new 3-D printer. Although she would have preferred to take it home with her and use time on the weekend to solve the problem, the printer was

too large for this to be feasible. If teachers cannot take devices home and learn about them during the summer or over the weekend, they are forced, by the nature of the technology, to learn in situ. When technology is not easily portable, teachers might need even more unstructured time to explore and learn about the device.

Conclusion

For the teachers in my study, technology-related learning was an ongoing, complex, and layered phenomenon. Formal, informal, and incidental learning experiences were all uniquely valuable and appreciated, and teachers relied on many types of professional learning opportunities as they integrated technology in the classroom. Lai (2011) has suggested a reciprocal relationship between informal and formal technology-related learning (p. 1270). That is, teachers might use informal learning experiences to make meaning from, extend, or enhance their formal learning experiences; likewise, they might use formal learning experiences to extend or enhance their informal and incidental learning. This was certainly true for the teachers in my study and might be true for other teachers as well. Although traditional, formal professional development models might sometimes be limited by their one-size-fits all, episodic nature, neither should informal and incidental learning pathways necessarily be viewed as the only—or even the preferred—methods to support teachers' technology-related learning. Extant literature and the experiences of the teachers in my study suggest that school, district, and technology leaders should value teachers' learning across the spectrum from formal to informal, creating contexts that are rich with many pathways to and opportunities for technology-related learning.

Appendix A

Researcher as Instrument

I embark on this research study under the influence of three important past roles. First, I spent 6 years as a classroom teacher. During that time, I worked in three different schools, with three very different contexts related to teacher learning, in general, and teacher learning related to technology integration, in particular. During that time, I had access to varying types of technology and experienced varying degrees of pressure from administrators to integrate the technology in my classroom. The second important role that I bring with me to this research is that of teacher technology trainer. I held this role for 3 years, and it not only came to define my professional identity, but also guided me onto the path I now approach the end of: my third important role, as adult student of educational technology.

In my capacity as a classroom teacher, I first taught 8th Grade Reading at a midsize, suburban middle school. It was a hard, hard job—in part, because I was new and the learning curve was steep, and in part, because the principal had no time for someone who was learning on the job. There was no culture of professional learning in this school, although we were piloting a new program called "Professional Learning Communities" (PLCs) that the principal had read an article about the summer before I started. When we met in our PLCs (really, just grade-level teams), we talked about the schoolwide discipline plan, state testing procedures, or teacher dress code (I still don't know if open-toed sandals are *really* professional dress). Later in my career, when I learned more about PLCs, I would look back on this time and shake my head in disappointment. We wasted a lot of time in those meetings and a lot of potential—I could have been doing a lot of

workplace learning in that protected space, leaning on my colleagues' experience to improve my own practice.

One conversation that started in PLCs carried over to a full faculty meeting. Our classes had piloted new test-prep software called Study Island. Each week, we were encouraged to reserve time in the 8th Grade computer lab, shuttle our classes down the long hallway (quietly!), and help them log in to Study Island. They would log in to painfully slow desktop computers, attempt to untangle headphone cords and ensure keyboards were plugged in, and then log in to a painfully slow website called Study Island. Once there, and with nearly half the class period elapsed, our students would answer math and reading questions modeled after the state standardized test. If they got enough questions correct, they were allowed to play a few minutes of a game, earn a few points, and then "advance" to the next level of questions. Just in time for us to log off of the computers, carefully put away headphones, and walk back down the long hallway (quietly!) to the classroom for class change. Rinse and repeat.

Using Study Island was not, in retrospect, a firm expectation. Many of my more experienced colleagues simply reported to our PLC that they "didn't have time" for it. But for a second year teacher, it certainly felt like a requirement. The principal had encouraged it, so I felt pressured to use it, even though I secretly felt my time would be better spent actually teaching my students content and skills in my own classroom. I did encourage students who were struggling on their benchmark tests to use Study Island at home. And I referred parents to Study Island if they were concerned about what they could do at home to help their students prepare for the test. But I never really liked the software. It was slow and the questions weren't really much like the state test; they were

similar, but the prep materials I had in my room had been developed by the state and matched the test exactly. Plus, my students groaned when I announced we were headed to the computer lab for another round of Study Island: "Those games are dumb, Ms. Ty."

I (naively) assumed that my colleagues secretly shared my disdain for the software. When the topic came up in PLCs, it was presented as, "Think about how your classes have been using Study Island. We'll be reporting out at the next faculty meeting." I had my notes ready! I had data! My students' benchmark scores had NOT improved because of Study Island. Most of them didn't have Internet at home, so they couldn't use the online portal for extra practice. The computer lab was far from my classroom, so we wasted a lot of time going there to use Study Island. My students didn't even like the software! Clearly, this had been an unsuccessful pilot.

Imagine my surprise when my colleagues overwhelmingly voiced their enthusiasm for Study Island: Yes, we should spend a lot of money buying the full version. Yes, they would use it (even the ones who "didn't have time" during the pilot). Yes, they could see it was helping students get ready for the test ("It has games; the students love games."). The principal was thrilled with our decision—after all, it was his idea to pilot Study Island. And his whole staff supported his idea.

At no time during the Study Island process, from pilot to full adoption, did we receive any training on how to use data from the program to improve our instruction. We did learn how to log in to the teacher portal and view which of our students was using Study Island at home, how long they had spent using it, and what their scores had been on any practice problems they had answered. I used this information as an incentive in my class: practice Study Island at home (or after school using one of the computers in my

classroom) and I'll replace one of your low grades with whatever grade you earn on the computer. A small handful of my 120 students took advantage of this.

By this time, I had realized that I could probably get away without going to the computer lab for a long time before my principal said anything to me about it. So I stopped taking my class to work on Study Island. That year, my students outperformed the other 8th Grade Reading teacher's classes on the state exam. She wasn't using Study Island, either, but she also wasn't doing a lot in the way of classroom instruction. Her students mostly completed worksheets or listened to her read a novel to them. My students worked hard, from bell to bell, and I tried to fly under the radar. When I left that job at the end of my second year teaching, it was with no regrets. I didn't feel like I had improved much as a teacher, but I did know enough to look for a different kind of workplace this time around.

My second teaching job was at a relatively small private school for students with mild to moderate learning disabilities. I was hired to work as a Reading Specialist for middle and high school students, but—as is the case in many smaller schools—I ended up wearing many hats outside of my role as Reading Specialist. I taught high school English and middle school Language Arts; I drove the bus on field trip days; I coached basketball; and I agreed to help out with a CD of long-neglected electronic textbooks one of the guidance counselors had stashed in her bottom desk drawer. Little did I know, this final task would completely transform my teaching career and lead me to finding my passion as an educator and lifelong learner. It was because of that neglected CD that I entered into my second important role, as technology trainer.

It was true that the CD contained copies of several electronic textbooks. However, what the guidance counselor apparently did not realize was that it also contained a software package designed to give students with print-related disabilities access to those electronic textbooks. There was a text-to-speech program that would read the textbook aloud to students; a word processing program with predictive typing that would anticipate the word students were attempting to spell; and a PDF reader that allowed students to zoom, highlight, and annotate PDF files for easier reading. Many of these capabilities have become standard in current educational technology offerings, but at the time, they were revolutionary. For the students I worked with who had print-related disabilities, this software package had the potential to change their lives. For those who struggled with executive function—keeping their notes organized and remembering where they read something when it was time to review for a test—the software was equally groundbreaking. I taught myself the software in a matter of days and by my second month on the job, I was training students how to use it.

Over the next 3 years, my job completely transformed, from full-time Reading Specialist (and part-time bus driver/basketball coach/cafeteria monitor) to part-time Reading Specialist and full-time technology trainer. I trained students, but I also spent ever-increasing amounts of time training teachers and parents how to use the software. As more teachers and students were using the electronic textbooks and software, the need for teacher websites increased. We began using Moodle, both as a place to host the software and textbook files, and as a place for teachers to post other online resources for their students. Students and parents loved this increased access to learning materials. Managing the Moodle was a full-time job all by itself, so I enlisted other teachers' help.

During our faculty-wide professional development days, I was now expected to conduct a training session or make a presentation, updating faculty about the state of educational technology in our school. I developed quick-reference guides, replete with screenshots, to help teachers remember how to do confusing tasks. In between these full-faculty sessions, I met with teachers one-on-one for training, called them to ask if they had the resources they needed, and monitored their Moodle pages remotely to troubleshoot problems they or their students encountered.

Along the way, I became a key resource person for my colleagues and the families at the school. They called on me for technology questions more frequently than they consulted me as a Reading Specialist. But for me, the two roles were inextricably linked. I loved teaching reading because it opened up a new world of independence and learning to my students. If they could read, they could go out and research anything they wanted to know: they did not have to wait for an adult to translate the textbook into a classroom lesson and they were not limited by what the textbook editors chose to include in the chapter. They could learn what they wanted, when they wanted, and in the medium they preferred. Teaching them to use the software package enhanced all of the capabilities my reading instruction was giving them. Now, they could learn from even more sources. Even if something was written at a higher level than they could read independently, they could often learn from listening. The text-to-speech software made this possible.

More importantly, they could read and understand what their peers were reading. Instead of having a visibly different (and lower-level) version of text—a common modification for students with learning disabilities—they could have an identical version

of the text and hear it read to them. Often, hearing the text while they read along to themselves and used the annotation tools to highlight, underline, and "mark up" the digital pages, was enough that students could immediately participate in a group activity related to the reading. Technology leveled the playing field for my students with learning disabilities. It allowed them to participate as equals with their neuro-typical peers in ways many of them had never before experienced in the classroom.

For me, the ability of technology to level the playing field for students has driven my passion to learn more about the best ways to integrate technology in the classroom. My time spent as a technology trainer for adults has given me insight into how powerfully important that position can be. I saw how essential it was to meet teachers where they were—literally, to go find them in their classrooms, and figuratively, to listen to what they were struggling with rather than trying to deliver a one-size-fits-all solution. Colleagues who were wary of any new technology came to trust that I would not expect more of them than they were ready for. They knew I would not ask them to try something unless it was intended to make students' lives easier. They became willing to take the risks required for their own learning because they had a patient and non-judgmental teacher.

By comparison to my first 5 years in the classroom, my final year of teaching experience was unremarkable. I spent a fun year teaching high school English, slipping into the easy rapport an experienced teacher builds with students. It was a low-stakes job; by February, I knew I had been accepted to a graduate program for Curriculum and Educational Technology at William & Mary. I knew I only had to last until June and then I would be free to pursue the next stage of my development as a technology educator. I

vaguely remember a few professional development sessions, but they exemplified the worst of what that term conjures up for most teachers: whole group meetings, in overheated rooms, with text-heavy PowerPoint presentations, and a facilitator who drones on about something that could have been sent in an email. None of them related to technology. The school also employed a technology resource teacher, but budget cuts had forced her into a dual role. She was responsible for a lot of our technology resources, but she also had to manage all of the paperwork and data for state testing. Which meant, for the most part, she spent her days managing all of the paperwork and data for state testing. That role did not leave a lot of room for technology training.

The school required teachers to maintain a class webpage and a colleague introduced me to Weebly. I had a website published in less than an hour and had a lot of fun over the next several months finding ways to use my website in ways that served students. For example, one of the things my students struggled with was choosing reputable online sources for their research papers. So, alongside our classroom lessons on evaluating the validity of online sources, I maintained a set of lists on my Weebly site: one list contained sources students had actually cited in their papers, but that were blatantly biased or flawed; the other contained sources I had vetted for accuracy and reliability. I also maintained pages with my "teacher notes" from each class session, study guides, and copies of handouts. I had carried these lessons with me from my previous job and knew how much time it saved in the classroom to say "Check the website" when a student asked, "What did I miss when I was out yesterday?"

This school used six laptop carts, checked out by teachers for computer-based assignments. There were lots of rules about the carts. Certain grade levels had them

during certain times of the year; teachers could only check them out in advance for two consecutive days; you had to write in pencil in the checkout book so the ladies in the Media Center could change your reservation if needed. I checked them out all the time. Even when I did not have a specific lesson planned, if the laptops were available, I reserved them. Then I got to work thinking about what I could do with them. In the English classroom, most of the time this involved a research or writing assignment. But occasionally, I would find an online resource—one that was not blocked by the school's web filter—that related to what we were learning. After my seniors read an abridged version of Macbeth, we used the laptops to create a comic-strip study guide before the test.

I learned that, even in the absence of any effective professional development, many teachers would seek out learning on their own. They talk to colleagues, they do their own research, and they try things that they think will help their students. In my last teaching job, I was on my own for professional learning. But I knew enough about myself as a learner, about my professional identity as a teacher, that I never felt lost. I just muddled through, focusing on what would be best for my students, and making adjustments when something did not work. (I also learned that laptop carts are the worst. Students never remember to plug the laptops back in; by the end of the day, most of the batteries are completely dead; and one wheel on the cart is always a little bit broken, making it impossible to push the cart in a straight line.) I came to believe that many veteran teachers were not that different from me. They took what they needed from professional development sessions, with very low expectations for substantial learning, and filled in the rest of what they needed on their own. They had trusted colleagues and

resources they regularly consulted, but they mostly kept their heads down and found their own way.

In my current role, as adult student of educational technology, I spend a lot of time reflecting on and interacting with the role of technology in schools. I have completed all of the coursework required to earn my doctorate in Curriculum and Educational Technology. For 4 years, I have taken graduate level classes that pushed me to think about the best ways to integrate technology and to lead others to integrate it. This semester, I completed an internship in a local school division, helping them develop their strategic plan for educational technology. In many ways, this project has been the culmination of all of my professional learning—as a teacher, as a technology trainer, and as an adult student of educational technology. I also maintain a professional blog, where I write about technology in the classroom for an intended audience of K-12 teachers, parents, and fellow researchers and edtech nerds.

As I have defined and redefined my own beliefs related to educational technology, there are several ideas that resonate with me:

- Educational technology has enormous potential to level the playing field for students from different socioeconomic backgrounds and who have a variety of learning abilities and preferences.
- Relationships are awfully important to teacher learning—the personal connection between technology trainer and teacher-learner (or the connection between groups of teacher-learners) often matters more than anything else.

- Teachers learn in many different ways and the informal and incidental ways they learn are just as important—if not more so—than the formal, planned pathways to learning.

As I embark on my dissertation study, I expect these beliefs to influence my interpretation of what teachers share with me and of what I observe in their classrooms. I expect to see teachers learning in a variety of ways, with varying degrees of effectiveness. I expect to see different contexts influence teacher learning in different ways.

I am not prepared to discover teachers' lack of curiosity or willingness to learn; this does not align with how I view teachers (or what the research shows about them) as lifelong learners. I am also not prepared to discover teachers who have the entirety of their learning needs met through formal channels (e.g., professional development sessions). Again, this finding would not align with how I view teachers or with what the research shows about them augmenting their learning through informal and incidental channels. However, I am committed to using the techniques of bridling, bracketing, and reflexive journaling to attempt to stay open to whatever findings I might uncover during the course of my research.

Appendix B

Guiding Interview Questions

Definitions to share prior to each interview:

- Informal learning is "intentional but not highly structured" learning that occurs in response to a problem or need for more information (Marsick & Watkins, 2001, p. 25).
    - Informal learning in the workplace may take several forms, but it shares several characteristics: it is job-embedded, triggered by a need to solve a problem, involves action and reflection, and is connected to others' learning (Marsick & Volpe, 1999, p. 5).
- Incidental learning happens along the way to answering a different question or solving an unrelated problem. In other words, incidental learning happens by accident or coincidence, when learners stumble across a piece of information they were not consciously looking for (Marsick & Watkins, 2001).

For first interview only:

- How do you typically learn about using technology in the classroom?
- To what extent, if at all, do you learn about technology integration from colleagues or peers?
    - How does this learning happen?
- To what extent, if at all, do you learn about technology integration on your own?
    - How does this learning happen?
- To what extent, if at all, do you learn about technology integration through trial-and-error?
    - How does this learning happen?
- What other ways, if any, do you learn informally/incidentally about technology integration?
    - How does this learning happen?
- Would you tell me more about how you learned to integrate [the technology I observed] in your classroom?

For interviews that take place after surveys, ask follow up questions based on participant's survey responses:

- Would you tell me more about [the informal/incidental learning experience(s)] you mentioned in your survey response(s)?

If participant seems stuck or asks for an example, prompt with one of the following. Only offer multiple prompts if conversation stalls.

- Have you learned about integrating technology through:
  - reading blogs?
  - using Twitter?
  - subscribing to a journal or magazine?
  - talking with a specific staff person?
  - using a particular resource in your school building?
  - talking with students?

If any organizational structures that support technology integration learning are mentioned:

- To what extent, if at all, do you learn about technology integration during/as a result of _____? (e.g., PLC meetings, common planning times, etc.)
  - How does this learning happen?

[*Note: The majority of the questions for the final interview arose from my analysis of data generated up to that point in the study (e.g., through prior interviews, participants' survey responses, and observation notes). During the final interview, I probed similarities and differences that emerged from my analysis of all participants' data.*]

For final reflective interview only:

- Thinking about [this comment/experience from another participant], to what extent, if at all, does that mirror your own experiences with learning informally and incidentally about technology integration?
- To what extent, if at all, has your participation in this study influenced your thinking about your own informal and incidental learning related to technology integration?

Appendix C

Participant Survey

[*Note: This is a text representation of the Qualtrics survey used, with radio buttons for options and conditional response items that appeared immediately below each learning example.*]

During the last two weeks, please mark which, if any, of the following types of informal/incidental learning you engaged in:

- Talking with a colleague about using technology in the classroom (yes) (no)
    - (if yes) Please describe what happened.
- Asking for help from a mentor, ITRT, media specialist, or other knowledgeable person about using technology in the classroom (yes) (no)
    - (if yes) Please describe what happened.
- Online research about integrating a particular technology in the classroom in general or into a specific lesson plan (yes) (no)
    - (if yes) Please describe what happened.
- Reading a book, article, or other type of digital or printed text to find out more about a particular technology (yes) (no)
    - (if yes) Please describe what happened.
- Another kind of learning about using technology in the classroom (yes) (no)
    - (if yes) Please describe what happened.
- Accidentally hearing about, discovering, or stumbling onto information that you found useful/helpful/interesting about using technology in the classroom (yes) (no)
    - (if yes) Please describe what happened.

Appendix D

Results Chart Excerpt

Codes Applied	Emergent Themes	Tentative Conclusion
informal learning incidental learning teacher learning preference learning obstacle learning need voluntary learning learning from peers or colleagues learning from family members learning from someone tech-savvy 1:1 help exploratory learning learning through trial-and-error learning from students learning from videos learning from a conference learning from a vendor learning from printed text learning along many pathways learning from a tutorial learning from a presentation school-based learning	Technology-avoidant teachers opt out when technology-related learning doesn't match their needs/preferences. Technology-savvy teachers opt out when technology-related learning doesn't match their needs/preferences. Learning preferences seem to influence teachers' engagement in technology-related informal/incidental learning opportunities.	Informal and incidental technology-related learning is driven by teachers' learning preferences.

Appendix E

Informed Consent Document

WHAT DO I HOPE TO LEARN FROM YOU?

This investigation, entitled **"A Phenomenological Investigation of Selected Teachers' Informal and Incidental Learning Related to Technology Integration,"** is designed to explore teachers' learning processes related to integrating technology in the classroom.

WHY IS YOUR PARTICIPATION IMPORTANT TO ME?

Studying your perceptions, reactions, and reflections related to your informal and incidental learning related to technology integration will allow me to view the learning process related to technology integration from the perspective of classroom teachers. I want to gather as much information as possible about your perceptions regarding technology-related informal and incidental learning, since this may assist other educators in identifying the most effective approaches for themselves to learn about technology integration.

WHAT WILL I REQUEST FROM YOU?

- Over the course of the Fall 2016 semester, I will ask you to participate in 3-4 interviews, which may take up to one hour each. With your permission, I will record these interviews to help in my later analysis of what you share.
    - After each interview, I will send you a summary of my notes related to what you shared. I will ask you to review these notes and send me any needed corrections so that I can ensure I accurately capture the experiences you share with me.
- I will ask to observe you in your classroom during at least one class period when you are using technology tools. If possible, this will happen near the beginning of the Fall 2016 semester at a mutually agreeable time.
    - If you participate in any structured informal learning activities, like PLC meetings, I may ask to observe you during this time as well, to gather more information related to your informal and incidental learning about technology integration.
- Over the course of the Fall 2016 semester, I will ask you to complete 3-4 short, electronic surveys, which may take up to 15 minutes each. I will send you a survey approximately one week after each interview to see if you've had any informal or incidental learning experiences related to technology integration since the last time we talked. During the next interview, I will ask you about learning experiences you shared in your survey responses.

ADDITIONAL INFORMATION:

Please know that:

- The confidentiality of your personally identifying information will be protected to the maximum extent allowable by law.
- Your name and other identifying information will be known only to the researcher through the information that you provide. Neither your name nor any other personally identifying information will be used in any presentation or published work without your prior written consent.
- The audio recordings of the interviews described above will be erased after the study has been completed.
- You may refuse to answer any questions during the interviews if you so choose. You may also terminate your participation in the study at any time. (To do so, simply inform the interviewer of your intention.) Neither of these actions will incur a penalty of any type.
- Your participation in this study is completely voluntary. If you decline to participate, this decision will not endanger any future relationship with the College of William & Mary.
- A summary of the results of the study will be sent to you electronically once they are complete.

HOW CAN YOU CONTACT ME?

If you have any questions or concerns about this study, please contact Diana Theisinger (dltheisinger@email.wm.edu) or my dissertation chair, Dr. Judi Harris (judi.harris@wm.edu) at The College of William and Mary, Williamsburg, Virginia (757-221-2334). If you have additional questions or concerns regarding your rights as a study participant, or are dissatisfied at any time with any aspect of this study, you may contact, anonymously if you wish, Dr. Tom Ward at 757-221-2358 (tjward@wm.edu) or Dr. Ray McCoy at 757-221-2783 (rwmcco@wm.edu), chairs of the two William & Mary committees that supervise the treatment of study participants.

By checking the "I agree to participate" response below, then signing and dating this form, you will indicate your voluntary agreement to participate in this study, and confirm that you are at least 18 years of age.

☐ I agree to participate.

☐ I don't agree to participate.

A copy of this consent form will be given to you to keep.

SIGNATURES:

Participant: _____ Date: _____

Researcher: _____ Date: _____

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Vita

Diana Lee Theisinger

b. September 1983 in Texas

Education

[2017] Doctor of Education
Curriculum & Educational Technology
College of William & Mary, Williamsburg, VA

[2008] Master of Education
Secondary English Education
Mercer University, Atlanta, GA

[2005] Bachelor of Arts
English Education
Texas A&M University, College Station, TX

Professional Experience

[2011-2012] English Teacher
Smithfield High School, Smithfield, VA

[2008-2011] Reading Specialist & Assistive Technology Coordinator
The Cottage School, Roswell, GA

[2006-2008] Reading Teacher
Woodland Middle School, East Point, GA