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Teachers' Self-Directed Informal Learning for Technology Integration in 1:1 Device High Schools

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TEACHERS' SELF-DIRECTED INFORMAL LEARNING FOR TECHNOLOGY INTEGRATION IN 1:1 DEVICE HIGH SCHOOLS

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ABSTRACT

Public schools are implementing 1:1 computing programs in the hopes of transforming education to provide students with the digital literacy competencies that will enable them to be successful in our technology driven world. Continuous professional learning is critical in helping teachers develop the knowledge and skills for effective educational technology integration. Research has found however, that formal professional development, commonly implemented as one-time workshops with outside facilitators, are ineffective due to the multi-dimensional nature of technology integration. Teacher continuous professional learning outside of the formal context needs be considered. This survey study explored the self-directed informal online and offline learning behaviors for technology integration of public high school teachers in schools during the early stage of 1:1 (ES1:1) device implementation programs. The findings from this study indicated that teachers are frequently engaged in informal learning activities for technology integration. Teachers regularly engaged in socio-constructivist activities through independent exploration, practice, and routinely asked their colleagues for help or to collaborate. Although searching the Internet to learn was the most commonly reported online activity, more sophisticated uses of technology to learn were limited. Teacher learning goals were also found to predict certain learner behaviors. The findings from this study inform both teachers and professional developers of the possibilities of informal learning as a legitimate form of professional lifelong learning.

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DEDICATION

I dedicate this dissertation to my family.

To my husband, Philip, who supports me in all facets of life, especially in my practice of being a lifelong learner. To my daughter Erika, whose high academic standards for her own dissertation journey are an inspiration. To my daughter Britt, whose patient ear, advice, and expressions of pride mean so much. To my daughter Jenna, whose insight into education and social issues helped clarify and expand my worldview. And last but not least, to my daughter Haley, who always showed interest in my study and gave me endless words of encouragement along the way. I love and

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CHAPTER 1

INTRODUCTION

Statement of the Problem

Teachers are under pressure to integrate technology into teaching and learning to better prepare students for success in a technology rich world. Although there are some "pioneer" teachers who are accomplishing meaningful technology integration into teaching and learning, it is occurring at a disappointingly slow rate (November, 2010; Lemke, 2010). A common solution is traditional one-time workshop style professional development for teachers, however it has not been effective (An & Reigeluth, 2012; Lawless & Pellegrino, 2007; Smolin & Lawless, 2007). Professional learning is critical in transforming schools and empowering students to learn through technology. If traditional professional development is not working then more current models need to be explored. This study will attempt to do that by exploring a common yet often overlooked strategy of teacher learning -- self-directed informal learning.

I became interested in the need for teachers to increase their knowledge and skills in digital literacy through my position as a high school library media specialist. I experienced first-hand how difficult it was for teachers to integrate technology into their teaching and learning. My awareness of the problem intensified when my school moved to a 1:1 device program in which every student in grades 9-12 were issued district provided devices. From this experience I made several observations. One observation was that teachers had different understandings of digital literacy that led to different perceptions of learning needs and goals. A second observation was that teachers seemed to prefer learning in informal settings with teachers from their own content area that they felt comfortable with working on relevant applications. A third observation was that teachers at different levels of technology integration in their practice benefitted from more personalized learning experiences. I was designated a teacher leader in technology professional development (PD) and soon realized that in

order to provide effective professional learning experiences, I needed to find out: How were the teachers who were more effectively integrating technology into their practice learning? Was their learning formal, informal, or a combination? Were they engaging in online or offline activities? Did they learn through social interactions with colleagues or through hands-on activities? Finally I wondered if there were a relationship between teacher engagement in informal learning and level of technology integration. These real life questions are guiding the inquiry of my study.

Background

Technology has created new demands on individuals in the way we live and work. As a result, teachers are being pushed to better prepare students to be college and career ready with a new set of digital literacy skills (U.S. Department of Education [USDOE], 2010; Partnership for 21st Century Skills [P21], 2011; Common Core State Standards [CCSS], 2010). With our increasing reliance on technology in all aspects of life, it is important for students to develop digital literacy competencies to be successful in school, productive employees, and empowered citizens in a global world (Kay, 2010, Hobbs, 2010). Teachers can help by learning how to effectively integrate technology into their practice.

Digital literacy and *technology integration* are commonly used terms in the literature about educational technology reform. The term digital literacy describes a repertoire of knowledge and skills that are essential to be productive citizens in our current global context of ubiquitous technology in all social, cultural, and economic practices (Hobbs, 2010; Tsitouridou & Vryzas, 2011). Stakeholders from the education, business, library, and political sectors have all weighed in on identifying the multi-dimensional conceptual framework for digital literacy. Important components include a range of literacies such as technology literacy, information literacy, and media literacy (Hobbs, 2010). Technology literacy is the ability to access, use, manage, evaluate, create, and communicate information. Information

literacy is the ability to locate, access, use, evaluate, and synthesize information. Media literacy education helps individuals develop the habits of mind to be critical thinkers of the media messages received and sent, effective communicators, and engaged citizens. Higher order skills of critical thinking, creativity, collaboration, and communication which have always been important in education, are frequently included in the frameworks for digital literacy because technology has affected the nature and importance of these skills (Rebora, 2009).

Digital literacy describes *what* we want our students to know and be able to do. It is a range of knowledge and skills that are essential to being successful citizens in today's technology rich world. Digital literacy should be part of school curriculum and integrated into all subject areas. Technology integration describes *how* teachers incorporate digital literacy competencies into practice. To operationalize the term" technology integration", Edutopia (2007) has offered this definition:

> Technology integration is the use of technology resources -- computers, mobile devices like smartphones and tablets, digital cameras, social media platforms and networks, software applications, the Internet, etc. -- in daily classroom practices, and in the management of a school. Successful technology integration is achieved when the use of technology is routine and transparent, accessible and readily available for the task at hand, supporting the curricular goals, and helping the students to effectively reach their goals.

Access to technology historically has been a major barrier to technology integration (Ertmer, 1999; Hutchison & Reinking, 2010; Sugar, 2005). But now close to 100% of teachers report having computers in their classrooms (Gray, Thomas, & Lewis, 2010), and more districts are prioritizing 1:1 device programs (Consortium for School Networking, 2013). Districts implementing district provided devices or Bring Your Own Device (BYOD) programs believe that access to technology has the potential to radically change the teaching and learning practices similar to the way our culture has been transformed by technology in other aspects of our lives such as communications, entertainment and ecommerce (Bebell & Kay, 2010).

Proponents of 1:1 device programs argue the benefits. Students will be more engaged in their own learning and their technology skills and academic achievement will increase. The results from studies of 1:1 device schools, however, have been mixed and varied. Student scores in writing but not math or reading increased at one middle school (Silvernail & Gritter, 2007). Another study found an increase in overall science scores (Dunleavy & Heinecke, 2007). A reduction in disciplinary actions and rates of attendance attributed to a higher level of student engagement at another 1:1 laptop school (Shapley et al., 2009). Several studies found that students developed stronger technology competencies when they had access to their own device (Bebell & Kay, 2010; Shapley et al., 2009).

Besides inconclusive and varied evidence on student achievement and other factors, critics argue that districts cannot afford or sustain the cost of 1:1 programs. Even though BYOD programs are seen as a cost-effective way to bring technology into the classroom, some contend that this kind of program only emphasizes the gap in access to technology for the economically disadvantaged students (Bruder, 2013). Although there are pros and cons, the current move to 1:1 device programs makes access to technology no longer the barrier it used to be (Ertmer, Ottenbreit-Leftwich, Sakik, Sendurur, & Sendurur, 2012) resulting in higher expectations for a shift in pedagogical practices.

The implementation of 1:1 programs is directly affecting teachers because the locus is shifting from inadequate access to technology, to teachers as change agents who meaningfully incorporate technology into teaching and learning. To this end, teacher professional learning must be addressed to realize any change in teaching practices. Researchers found that preliminary PD for teachers in 1:1 device schools was critical for successful implementation of technology in practice (Shapley et al., 2009). Well planned and frequent training sessions were identified by teachers to be essential to successful integration technology into teaching and learning (Lowther et

al., 2007). Researchers also found that PD was most beneficial when the focus was on both technology mechanics and the integration of meaningful technology into the curriculum (Bebell & Kay, 2010). This study will build on this research by exploring teacher self-directed informal learning approaches to successful technology integration in 1:1 schools.

Before delving further into self-directed informal learning, it is important to understand the history of PD and technology integration since it is an essential component to teacher learning and change. A common type of technology PD is a one size fits all, school or district provided workshop or class with a facilitator contracted from outside the district. Despite the prevalence of this kind of formal PD, there is still dissatisfaction concerning its effectiveness, uncertainty over the best delivery model, and complaints for lack of relevance (Hutchison & Reinking, 2010). The knowledge that has come out of the research body is that effective features of PD have been identified: relevance to content area, active work on meaningful products, social interaction, prolonged time and opportunity for reflection (Borko, 2004; Desimone, 2009; Penuel, Fishman, Yamaguchi, & Gallagher, 2007). Scholars, however, have argued that integrating technology into teaching and learning is a difficult, multi-faceted process that requires more comprehensive PD to effectively address its complexity (Mills & Tincher, 2003; Mishra & Koehler, 2006). Over the past fifteen years, new comprehensive models of technology PD were the focus of research, yet issues still remain.

One issue concerns the sustainability of comprehensive PD models. For the past twenty years, the U.S. Department of Education drove much of the effort for multi-dimensional technology PD by investing between $750 million and $1 billion in training for teachers (Pellegrino, Goldman, Bertenthal, & Lawless, 2007). Preparing Today's Teachers for Tomorrow (PT3) is one example of a grant program that provided over $275 million to study multi-level PD models grounded in collaborations

between schools of education and local districts (Brush et al., 2003). These formal PD models incorporated a variety of learning experiences such as mentoring, lesson design, observation, workshops, sustained discussion, and reflection (Cole, Simkins, & Penuel, 2002; Mitchem, Wells, & Wells, 2003; Rosaen, Hobson, & Khan, 2003). The multi-dimensional learning experiences provided more meaningful and effective learning of technology for both pre-service and in-service teachers. However, once the grant money was used up, they were discontinued. Multi-dimensional PD of this nature proved difficult to sustain economically.

Our understanding of teacher learning of technology integration has also been limited by the narrow focus of research on formal PD models. An exhaustive literature review during a five-year period by Lawless and Pellegrino (2007) identified twenty-one studies on formal models of PD for technology integration. These models were designed around a combination of approaches such as peer mentorship, train the trainer, individualized learning, collaborations, content focused inquiry, and lesson design. However none of these studies, including the PT3 research, examined learning outside of the formal context. The researchers concluded that in spite of these studies of formal PD, many questions about what works and why were still unanswered.

Some experts have responded by proposing the need to completely change the way we think of professional development from formal episodic events to one of continuous professional learning (Easton, 2008; USDOE, 2010). They argue that in continuous professional learning, teachers can personalize their own learning by taking responsibility for it. Learning can become part of teachers' daily routine in informal settings both inside and outside of school. Moreover, online learning opportunities, with their anytime anywhere nature, have the potential to support a model of continuous professional learning.

Significance of the Study

This study is significant on several levels. First, exploring the ways teachers are self-directing their learning of technology may inform teachers' themselves as learners with unique learning needs or styles. Second, stakeholders may also use the findings to develop smarter approaches to professional learning. Third, the research base on trends driving innovative learning of technology for teachers needs to expand. These trends are: (a) the importance of lifelong learning for educators, (b) the understanding that much of adult learning happens informally, and (c) the potential of the Internet and Web 2.0 tools to provide new learning opportunities that allow for more personalized learning, anytime and anywhere.

The first trend driving the need to look at PD differently is the concept that teachers need to keep up with the rapid technological changes by being lifelong, continuous learners (Webster-Wright, 2009). Instead of thinking of PD as a solution for a deficiency in teacher knowledge, we should think of teachers as learners who engage in and personalize their own learning based upon their interests and perceived needs throughout their career (Easton, 2008). The idea that teachers take responsibility for their own continuous learning is built on Knowles' (1975) adult learning theory of self-directed learning (SDL). SDL falls under the umbrella of lifelong learning where learners take the initiative to identify what they need to learn, what resources to use, in what context to learn, and in what types of learning activities to participate.

Evidence indicates that teachers are already engaging at a high rate in SDL for technology integration. For example, in a national survey, teachers were asked about the kind of training that prepared them to effectively integrate technology in instruction, and 78% reported that they learned it through "independent learning" (Gray et al., 2010). In another national survey, 95% of the teachers who responded said that they "taught themselves" how to use technology (US DOE, 2003). I suggest that the terms "independent learning" and "taught themselves" infer the principles of

SDL because learners are taking the responsibility to identify what to learn and how to learn it. Although these few studies have indicated the high frequency of teacher engagement in SDL for technology; the nature of these activities has not been explored. This study aims to add to the knowledge base on teacher SDL for technology integration by looking more closely at what teachers are identifying as their learning goals and the kinds of learning activities they engage in.

The second trend driving the need for a new approach to professional learning is an interest in understanding the role of informal learning and how it can support teacher professional learning (Vrasidas & Glass, 2007; Schwier, 2010; Straub, 2009; Webster-Wright, 2009). Informal learning is when "individuals take the initiative, with or without the help of others, in diagnosing their learning needs, formulating learning goals, identifying human and material resources for learning, choosing and implementing appropriate learning strategies, and evaluating learning outcomes" (Knowles, Holton, & Swanson, 2005, p. 18). The prevalence of informal learning is surprisingly substantial. Research has shown that it accounts for 80% of adult learning (Schugurensky, 2000). In regards to teacher learning of technology, the research findings indicate a high rate of informal learning. In a national study exploring how technology was being used in the classroom, 88 % of the respondents said that they learned technology from other educators at school, 78% from family and friends, and 50% from students (USDOE, 2003). Evidence of the high rate of informal learning of technology for educators warrants the need to better understand what this looks like.

The third trend driving my study is the potential of the Internet and Web 2.0 tools to provide new learning opportunities for teachers (Burbules, 2007; USDOE, 2010; Vrasidas & Glass, 2007). The Internet provides convenient and immediate access to resources never before attainable. Web 2.0 technology provides opportunities for social learning through online conversations and collaborations because it allows people to not only consume information but to produce and share it

with others (Brown & Adler, 2008). For example, educators have the ability to choose from social networks, online professional learning networks, blogs, wikis and other online learning tools and resources to support their continuous professional learning. Since technology has opened up boundless possibilities for socially constructed learning, this study will pay particular attention to the kinds of learning that is happening online.

Research Questions

The purpose of this study is to explore teacher self-directed learning (SDL) experiences for the integration of technology into teaching and learning. The research questions are:

1. What is the nature and frequency of teacher SDL experiences for technology integration?
    a. What is the relationship between formal and informal learning experiences?
2. How do teacher personal learning goals and demographics relate to engagement in SDL activities for technology integration?
3. What is the relationship between teacher level of technology integration and their SDL experiences?

Overview of the Research Design

This study used survey research to explore the nature and frequency of SDL for teacher technology integration. It also examined correlations between the level of technology integration and engagement in SDL, as well as the correlation between contextual factors of learning goals and teacher characateristics to engagement in SDL. A web-based survey instrument was used for its economy of design, familiarity to respondents, and quick turnaround. The tailored survey design method was followed because it builds social exchange and encourages response (Dillman, Smyth,

& Christian, 2009). Data was collected during a two-week window during the second quarter of the 2014 – 2015 school year.

Population and Sample

The population for this study was 280 teachers from three purposely selected public high schools in Rhode Island that were in the early stages of 1:1 (ES1:1) device programs. The definition of 1:1 device programs is a school that is implementing a program where every student has individual access to a technology either through a BYOD program or through a district provided device program where students are issued devices such as a laptop or Chromebook. Selecting ES1:1 schools minimized the variable that a lack of access to technology may have on teacher SDL practices. Schools selected were in an early stage, either their 1st or 2nd year of implementing BYOD or 1:1. These initial implementation years commonly focus on teacher PD so the topic of the study was meaningful and relevant to these teachers.

Instrument Development

Although it takes time and effort, I designed the survey instrument for this study for two reasons. First, there was no existing instrument that measured the frequency and nature of teacher SDL activities for technology on a granular level. Closed and open-ended questions were designed to help create a clearer picture about both the kinds of SDL activities teachers were engaging in to learn technology and their learning goals. Second, there was no instrument that measured the level of technology integration using teachers' own words. The current frameworks for measuring or defining technology integration have been created by scholars who have a high expertise in technology integration. As a result, they tend to use wording that may not take the novice's perspective into account (Gorazon, Ennels, & Hammeron as cited by McGrath, Karabis, & Willis, 2011). To minimize the comprehension issue, the survey used an open-ended question enabling teachers to describe their technology use in their own words.

The instrument created for this study was called the Teacher Learning Activities for Technology Integration (TLATI) survey. It consisted of scaled, categorical, and open-ended questions. I used a series of steps from brainstorming items informed by my study of the literature, to interviewing teachers, and to conferring with experts to ensure content-related reliability (Fraenkel, Wallen, & Hyun, 2012). For instrument layout and wording, I referred to the tailored survey design principles from Dillman et al., (2009). The intent of tailored survey design is to minimize non-response error by using easy to understand words, a clear layout, and by creating social exchange by appealing to teachers' inclination to want to help and contribute to the profession on a meaningful topic.

Prior to implementation, a pilot survey using the cognitive validation method was administered to four teachers. Cognitive validation is an interview method where participants either simply think aloud at what they think the question is asking, or the interviewer asks more detailed questions while the interviewee thinks aloud. This method is useful because it provides feedback from respondents that help validate the content (Beatty & Willis, 2007).

The survey was implemented at the end of November, 2014 using SurveyMonkey, an online survey software program. A two-week response window with a planned timeline of introductory information, survey invitations, and reminders was part of the data collection process.

Data Analysis

Multiple data analysis strategies were used. First, the data was cleaned and analyzed using SPSS statistical software. Then descriptive statistics were run on the quantitative data. Factor analysis for learning activities was conducted to determine if any of the granular items clustered together to offer broader insights into teacher informal learning behavior. Next, the participants' open-ended answers were inductively coded into five or six themes. Besides eliciting more contextual detail

about technology integration and learning experiences, the open-ended questions also provided a means to triangulate the quantitative data. This process allowed me to see trends, obtain more detail and corroborate the quantitative data. Lastly, I calculated linear regressions to explore relationships between variables to answer my research questions.

The results indicated that teachers are regularly engaging in informal learning activities for technology integration. Teachers commonly take time to explore and practice with technology on their own. They often seek help through social interaction with tech savvy colleagues in their school. They routinely learn by researching on the Internet. Furthermore, what teachers chose to learn is important and can predict the types of learning activities they engage in and their level of technology integration. The findings from this study can inform both teachers and professional developers as they develop and plan appropriate supports for successful technology implementation initiatives.

Organization of the Dissertation

This dissertation is organized into five chapters. Chapter 1 introduces the research problem, background information and significance of the study, research questions, and provides an overview of the research methods and data analysis procedures. Chapter 2 reviews the literature on two topics, adult self-directed learning with an emphasis on informal and online learning, and digital literacy and technology integration in educational practice,. Chapter 3 provides a detailed description of the methodology used in this research study. Chapter 4 reports the findings from the data analysis. Chapter 5 presents a discussion of the findings, implications, limitations, and recommendations for further research.

CHAPTER 2

Literature Review

Introduction

Technology has created new demands on individuals in the way we live and work. As a result, educational institutions are being pushed to better prepare students to be college and career ready with a new set of digital skills (CCSS, 2010; P21, 2011; USDOE, 2010). Even though today's youth has grown up with the Internet, social media, and related technology as part of their everyday lives (Ito et al., 2008; Lenhart, 2015; Lenhart, Ling, Campbell, & Purcell, 2010; Lenhart, Purcell, Smith, & Zickuhr, 2010), the transition to incorporating digital literacy experiences into education has yet to be fully realized (Jacobs, 2010; Pellegrino et al., 2007). Moreover, technology use in schools should not simply make traditional teaching and learning more efficient. Rather, "we need to engage faculty and students with examples and experiences that capitalize on the power of new media and tools to support learning with understanding" (Pellegrino et al., 2007, p. 83). For this kind of change to happen, teachers must envision a new way of teaching and learning that incorporate digital literacy.

The federal government made an effort to lead the way with the National Education Technology Plan (USDOE, 2010). One of the goals was to create and implement standards and learning objectives using technology for all content areas that reflect 21st century learning expertise such as critical thinking, collaboration, complex problem solving, multimedia communications and technical competences (USDOE, 2010). Clearly, understanding what this looks like and how to implement it in practice is a fundamental change on many levels for teachers who have been using the sage on the stage, one-size fits all factory model that has pervaded education for the past 100 years. Although there are pockets of innovation, change has been slow.

To realize a new way of teaching, teachers will require a deep understanding of content, pedagogy and technology to effectively use technology in their disciplines

(Dilworth et al., 2012; Koehler & Mishra, 2005). Therefore, if the success of education technology integration is dependent on new understandings of how technology can transform the education model, then professional development for all teachers is the most important work to accomplish this change (Kay, 2010; USDOE, 2010). The majority of professional development has been the one-time workshop facilitated by an outside leader and does not embody what researchers have found to be characteristics of effective professional development (Wei et al., 2009). These characteristics include collaborative learning opportunities, hands-on learning activities, relevance to content area, sustained periods of time and reflection (Borko, 2004, Desimone, 2009; Penuel et al., 2007). Since one-shot workshops, the most prevalent format for professional learning of technology, are not meeting the needs of teachers a fresh approach is warranted.

Additionally, professional development for technology integration has received lackluster reviews (Lawless & Pellegrino, 2007). In a survey sponsored by the U.S. Department of Education, 35% of the teachers who responded reported that professional development activities specifically designed for education technology integration did not prepare them to make effective use of it in the classroom (Gray et al., 2010). Specific criticisms from teacher evaluations of professional development programs commonly cite those experiences as too broad, not subject specific, and not allowing sufficient time for the amount of information being relayed (An & Reigeluth, 2012). Clearly, better ways to support teacher learning needs for technology integration should be explored.

This study examined how teachers are learning outside of traditional professional development (PD) by exploring their informal learning experiences for technology integration. The philosophical perspective of this research study was informed by the socio-constructivist learning theory. The socio-constructivist learning theory defines the learning process as when the learner constructs knowledge through

social interaction (Vygotsky, 1978) combined with relevant hands-on activities and experiences (Fosnot, 1999). From the framework of the socio-constructivist learning theory, I will look at the nature and frequency of teacher self-directed informal learning activities for technology integration. In tandem with this exploration, my assumption is that self-directed learners who engage in informal, socially-mediated constructivist learning activities will report higher levels of technology integration.

The following review of the literature will address two core areas of interest. The first section will review the literature on adult self-directed learning (SDL) with a focus on informal and online learning. The second section will review the literature on digital literacy and technology integration in education.

Adult Self-Directed Learning

Integrating digital literacy into teaching and learning is a complex process that is more difficult to attain than many stakeholders realize. There are a large number of interconnected and contextually bound variables such as (a) teacher knowledge and skill (Hew & Brush, 2007; Hutchison & Reinking, 2010; Inan & Lowther, 2010), (b) access to technology (Bebell & Kay, 2010; Hew & Brush, 2007), (c) teacher beliefs about the value of technology in education (Ertmer, 2005; Ertmer et al., 2012; Paraskeva, Bouta, & Papagianni, 2008); and (d) resources within the school structure (Hew & Brush, 2007; Hutchison & Reinking, 2010). Although there are multiple variables to technology integration, the intention of this study was to explore aspects of the first variable, teacher knowledge and skill, by looking at how teachers are self-directing their own informal learning. The impact of the second variable, access to technology, was purposely reduced by sampling teachers in 1:1 or BYOD schools, The third and fourth variables, teacher beliefs about the value of technology in education and school resources have been explored in numerous studies (Hew & Brush, 2007; Hutchison & Reinking, 2010) and will not be explicitly addressed in this study.

The possibilities of teaching and learning with technology have caught the imagination of many stakeholders yet have often been characterized as a "wicked problem" because of the multiple factors involved (Borko et al., 2009, p. 3). These researchers explain "The rapid growth of digital technologies, coupled with the complexity of classroom life, increases both the transformative power and the difficulty of problems associated with incorporating innovative technologies in teaching and teacher education" (p. 3). New methods of professional learning are needed that provide teacher learning opportunities in more relevant and authentic ways. One approach is to reframe teacher education from a traditional professional development model where teachers simply receive training, to a model of lifelong professional learning. In this model teachers take a more active role and become self-developing learners, and much of the learning takes place in informal settings (Easton, 2008). Inspired by Easton's vision of teachers as lifelong professional learners, this study is supported by the theory of SDL.

SDL falls under the umbrella of lifelong learning. Lifelong learning is a term used to describe the cumulative learning experiences which occur across the entire lifespan, from infancy throughout adult life (Belanger, 1994; Brockett & Heimstra, 1991; Tuijnman & Bostrom, 2002). However, since this research study is examining in-service teachers, it will focus on adult learning, the phase of lifelong learning that continues after formal, institutional schooling ends.

For the past several decades, there has been a growing recognition of the importance for lifelong learning in response greater competitiveness in a world market, especially in regards to the rapidly changing technological advances in the workplace (Edwards, Ranson, & Strain, 2002; Merriam, Caffarella, & Baumgartner, 2007). As a researcher, my interest in lifelong learning stems from my career in the library profession which historically has emphasized the value of lifelong learning. Currently, lifelong learning has been prioritized as a curricular goal by the American

Association of School Libraries in their Standards for the 21st Century Learner in Action (2009) and is one of five key action areas adopted by the American Library Association (2015) to fulfill its mission of promoting the highest quality library and information services for all people. In today's world of rapidly evolving technologies, lifelong learning is more important than ever.

The following section will look at self-directed lifelong professional learning for technology integration from three vantage points. First I will provide background on SDL theory. Second, I will describe the different learning settings for SDL. Last, I will examine the literature on the potential of SDL in a digital world.

Background

Teachers are being called on to take responsibility for their own self-development to integrate technology and engage students in learning experiences mediated by digital technologies. In fact, we are in the era of the "Engaged Learner" where today's learner is a "motivated, engaged seeker and the learning process is developmental and anchored in a sociocultural context" (Alexander & Fox, 2004, p. 54). This study attempted to examine teachers as engaged learners of technology integration in the sociocultural context of BYOD or 1:1 device high schools. This context was chosen because these schools were focusing on teacher professional learning to transform educational practices with digital resources and technology.

SDL as a field of research began with Tough's groundbreaking study in 1971, The Adult's Learning Project (Livingstone, 2001). His study of 66 participants in Canada was the first comprehensive description of adult self-directed learning. He found that 70 percent of all adult learning projects were planned by the learners themselves. Tough identified 13 learning steps that adults went through as they planned their learning. This initial research brought attention to the concept of adult learning and opened up a large wave of research on self-planned and self-directed learning (Merriam et al., 2007).

Knowles (1975) expanded on Tough's work by offering a conceptual framework of self-directed learning as a "process in which individuals take the initiative, with or without the help of others in diagnosing their learning needs, formulating learning goals, identifying human and material resources for learning, choosing and implementing appropriate learning strategies, and evaluating learning outcomes" (p. 18). Interest in adult learning theory developed from Knowles' ideas and related concepts on self-direction as a learning process appeared in the literature during the 1980s. Notions of the "autonomous learner," were developed an individual who can "identify his learning need when he finds a problem to be solved, [is able to] define fairly explicitly his criteria for successful development and judge the appropriateness of newly acquired skills, the adequacy of his solutions, and the quality of his new ideas and knowledge" (Moore p. 23 as cited in Brockett & Heimstra, 1991).

SDL is acknowledged to be a complex process with multiple variables including readiness traits for SDL, (Kirk, 2012; Merriam et al., 2007). These traits include high degrees of self-efficacy, meaning the belief that one can achieve a goal; intrinsic motivation; and the ability to set goals and choose appropriate strategies to reach them (Oddi, 1987; Brockett & Heimstra, 1991). Although I acknowledge that personality traits impact SDL, the purpose of this study is not to explore readiness traits for SDL, but to focus on what teachers are identifying as their learning goals and the informal learning strategies they are engaging in to reach them (RQ1).

Formal, Non-formal and Informal Learning.

SDL experiences can take place in three different types of settings: formal, non-formal, and informal (Candy, 1991; Merriam et al., 2007; Schugurensky, 2000). Formal learning is learning that happens in the settings of schools and institutions of higher educations. It is easy to identify because it is a highly structured event, led by a teacher or facilitator, using prescribed curriculum and sponsored by a bureaucratic organization or institution. Non-formal learning occurs in community settings and is

sponsored by organizations such as libraries, community centers or professional organizations. Non-formal learning environments are usually led by an expert or facilitator and there may or may not be a formal curriculum or learning outcomes. Informal learning, the focus of this study, happens in work and daily settings outside of formal institutions. Schwier (2010) adds that "informal learning can address all kinds of questions, but it is always driven by learner needs or curiosity" (p. 91) rather than follow a prescribed curriculum. Since informal learning activities and behaviors are of interest in this research, activities in non-formal and formal learning settings will be combined into one category called Formal Learning for data analysis.

The research on adult informal learning has provided a detailed understanding of it. Informal learning is a substantial phenomenon, accounting for about 80% of all adult learning (Eraut, 2004; Hague & Logan, 2009; Livingstone, 2001; Schugurensky, 2000). Informal learning can be broken down into two types; intentional and incidental. Intentional, or self-directed informal learning is a process where learners take the initiative to diagnose their own learning needs, formulate their own learning goals, and determine the resources, time and direction of the learning all in the absence of an identified instructor or assigned leader. Incidental learning is the kind of learning that happens as a part of everyday experience. It occurs spontaneously through daily interactions with people. Incidental learning is difficult to measure because individuals may not even be aware of their learning until after it happens, or they take this kind of learning for granted. Due to the nebulous nature of incidental informal learning, it will be outside the scope of this study. Instead, this study will explore the intentional informal learning of teachers for technology integration and will refer to it as self-directed informal learning. The next part of this literature review will begin with a narrow focus on the self-directed informal learning of teachers and educational technology and then proceed to look at it in a broader context.

Large scale survey evidence indicates that teachers are already engaging at a high rate in self-directed informal learning for technology integration. For example, 3,300 teachers in a nationally represented sample of school districts were asked about the kind of training that prepared them to effectively integrate technology in instruction, 78% reported that they learned it through "independent learning" (Gray et al., 2010). In a survey of districts that had applied to the Technology Literacy Challenge Fund for federal funding, 95% of the teachers who responded indicated that they "taught themselves" how to use technology (USDOE, 2003). I propose that the terms *independent learning* and *taught themselves* infer the principles of self-directed informal learning because learners are taking the responsibility to identify what to learn and how to learn it. Although these studies have indicated the high frequency of teacher engagement in self-directed learning in informal settings for technology integration; the nature of these activities has not been a focus of research (Jurasaite-Harbison, 2008; Schwier, 2010). Therefore, this study aimed to expand the research base on teacher informal learning of technology integration.

Informal learning has been studied in different contexts other than teacher learning of technology and an overview of this research will help shed light on the phenomenon. Eraut's (2004) article synthesized his own and other scholars' interview research and reported on four factors that affected informal learning in the general workplace. The first factor was that the local workplace climate affected learning. If there were time, space, and administrative support for informal learning, then it was more likely to happen. A second factor was when the learning activities were embedded in daily work, informal learning was more effective. A third factor was that people learned more when they received feedback on their learning. A fourth factor was that a feeling of confidence by both novice and experienced workers was important in informal learning. Eraut suggests that these findings can be generalized to a variety of contexts, including education.

Informal learning can also look different for different people. A study of teachers learning a new instructional strategy for active student learning, found that they differed in the way they learned informally (Hoekstra, Brekelmans, Beijaard, & Korthagen, 2009). Some teachers wanted feedback, some wanted a safe learning environment to practice, and others wanted more specific guidance from experts. The researchers proposed that supports for informal learning should consider a range of teacher learning needs to be more successful.

Research on informal learning also emphasizes the situational aspect of adult learning (Eraut, 2004; Hoekstra et al., 2009). Situated learning is more than just on the job learning by doing. Situated learning addresses the relationship between learning and the social situations in which it occurs (Lave & Wenger, 1991). In situated learning, the interaction of peers and the circulation of knowledge and skill moves between people new to the skill and those who have more experience. Situated learning is similar to peer mentorship but is more informal. These kinds of knowledge sharing relationships involving novices and experts are often part of informal learning experiences (Eraut, 2004).

Informal learning for teachers has its critics. A research paper pointing out the limitations of informal learning for teachers was reported by Hoekstra and Korthagen (2011). They studied 32 new teachers in the Netherlands to find out whether their professional knowledge and skills changed through day to day informal learning as opposed to working with a mentor in a structured relationship. They found that an informal learning context may not provide the necessary supports for new teachers to develop as professionals. They suggest that planned modeling by a mentor in combination with discourse would increase motivation and awareness of their learning.

Other researchers have looked at the informal learning behaviors of youth and technology. Ito et al.'s (2008) well known ethnographic study of youths' informal

learning outside of school painted a vivid portrait of what it looks like. Young people are learning the behaviors and habits of mind to live online by creating, sharing, connecting, and communicating using their mobile devices in a social context that is completely disconnected from learning at school. Furlong and Davies (2012) interviewed 132 youth ages 8 – 21 and argued that the informal learning practices of youths using technology at home can increase their sense of agency in relation to their overall learning. Although these research studies help us understand the way youths learn informally with technology, this research study will add to the research base on teachers as adult learners, using technology to create new knowledge. Understanding informal learning behaviors of teachers may help improve professional learning supports for technology integration.

To better understand how to support informal learning, it helps to look at Lohman's (2000) study on the barriers to informal learning for teachers in the workplace. Twenty-two experienced teachers were interviewed and observed and four environmental factors emerged as barriers to informal learning. They are: (a) lack of time for learning, (b) lack of proximity to learning resources, (c) lack of meaningful rewards for learning, and (d) limited decision making power in school management. He argues that informal learning as a method of adult education needs to be promoted and suggests ways to restructure the organizational environment to be more conducive to self-directed informal learning.

Teacher informal learning for technology integration and more general research on informal learning including barriers was just reviewed. It is apparent that the research base on teacher informal learning needs to grow because it is an important piece of teacher professional growth. This study will add to the knowledge base by exploring not only how often, but in what ways teachers informally learn to integrate technology into professional practice and help answer RQ1. The potential of technology to impact informal professional learning activities will be discussed next.

Informal Professional Learning and Technology

Thought leaders have suggested that the Internet and innovative technology tools can provide new ways and opportunities for learning (Dede, 2007; Knobel & Wilber, 2009; Webster-Wright, 2009). Specifically for teachers, general consensus is that technology has the potential to provide more resources and activities for them to self-direct their own learning (Hague and Logan, 2009; Rebora, 2009). Examples culled from the literature include: Social networking technology tools that enable educators to proactively create personalized learning opportunities for themselves on demand (Speak Up 2014, 2015); 24/7 access to information and resources on the web that minimize time and distance constraints (Starkey, 2012); personal learning networks that allow educators to continuously improve their skills through interactions with others (Ballard, 2012; Gray, 2004; Trust, 2012); micro-blogging tools such as Twitter to connect with experts and resources for professional learning (Dremski, 2010); and online professional development modules or webinars that have the potential to reach large audiences at a fraction of the costs of face to face workshops (Dede, 2007). Clearly, technology and Web 2.0 tools can provide new ways to learn.

Although these ideas are intriguing, there is only a small body of research on the actual use of digital technologies for adult learning. One such study from Great Britain was conducted with 1,971 adults on the use of technology to support adult learning. Ninety-four percent of the respondents reported some kind of informal learning activity in the past three months and four out of five of all adults said they use some kind of technology to help them learn informally. The top technologies used were the Internet (58%), TV, DVDs or videos (53%), search engines (50%) and email (32%) (Hague & Logan, 2009). Participants also identified the benefits of using technology to learn. The most frequently cited reasons were: it was quick and saved time (37%), they could find out more information (34%), they could learn when they wanted (31%), and that it saved hassle (18%).

The European Commission conducted in-depth case study research that explored how adults participate in online communities for intentional informal learning in the interest of socio-economic policy (Ala-Mutka, 2010). Success factors for online collaborative learning included adult's engagement in accessing and reading online resources, discussion with other members, and contribution of ideas. Although technology skills and motivation were acknowledged barriers, their findings indicated that online collaborative spaces can support informal learning in new ways.

With the number of adults owning mobile devices increasing, Clough, Jones, McAndrew and Scanlon (2007) explored whether the use of mobile devices such as smart phones supported informal learning. Their findings indicated a variety of ways adults used mobile devices for informal learning such as taking notes, recording ideas, taking photos, listening to podcasts, sharing information and looking up information on the Internet. Those people who used their mobile devices most often for intentional informal learning were described as mobile device "enthusiasts" (p. 370). The researchers concluded that since enthusiasts had already developed a level of confidence and competence by integrating mobile devices in their daily lives, it was more natural to use them for a learning need.

Teachers' use of Web 2.0 and social media technologies in their professional activities was also evident from the findings of a survey sent to 200,000 teachers, principals and librarians (MMS, 2012). Web 2.0 technologies are defined as digital technologies that allow users to produce and share content on the web as well as consume it. The top Web 2.0 tools for professional use were reported as webinars (48%), document sharing (34%), wikis (25%), and social networks (22%). This study has several limitations. One is that the response rate was only .35%. The likelihood of a representative sample is in question because more tech savvy educators may have been inclined to take the survey because they perceive it as more important and valuable than novices. Another limitation of the survey is that it does not specify what

it means by the term "professional" use of the tools. It could be for professional learning or other uses such as professional career advancement or productivity. Regardless of these limitations, the use of digital tools for learning is an area of interest for teachers. This study will add to the research base about the kinds of online learning and digital tools teachers are using to help them learn educational technology integration.

I just presented the section of my literature review on adult self-directed learning. I first provided a background on self-directed learning and then discussed research on informal learning and finished with a review of the literature on online informal learning. This deep review of the literature informs and validates the need for my study of the informal and online self-directed learning activities of teachers for technology integration. In the next section I will review the literature on technology integration and digital literacy. I will first describe technology integration and digital literacy. Then I will look at the conceptual frameworks and their place in research. Lastly, I will discuss common factors affecting teacher success in technology integration.

Digital Literacy and Technology Integration

Digital literacy and technology integration are popular terms used in the discourse about educational technology reform. This study uses the term, "technology integration" to describe teachers' practices using technology to incorporate digital literacy competencies into their teaching and learning. The shift to 21st century teaching and learning in a digital world however, is more complex than just knowing how to use technology tools to enhance learning.

Digital literacy describes what we want our students to know and be able to do and it is important to fully define the term to help make sense of the incredibly complex task facing educators. *Digital literacy* is an umbrella term that captures the

meaning of numerous and complex skills that have and continue to evolve due to the impact of technology and the Internet. Multiple stakeholders from the political, economic and education fields; domain experts in information literacy, technology literacy and media literacy; and scholars have all weighed in on what they view as important digital literacy skills (Hobbs, 2010).

General consensus is that digital literacy skills are multi-dimensional, interwoven abilities which include technology skills from basic functions to more sophisticated uses; cognitive skills such as critical thinking, collaborating, communicating and creating (International Society for Technology in Education [ISTE], 2007; P21, 2011; USDOE, 2010); socio-emotional skills involving the development of the habits of mind for lifelong learning and ethical judgment in a global world (Aviram & Eshet-Akalai, 2006**;** P21, 2011, Ribble, 2011); information literacy skills such as searching for information, the ability to critically evaluate and use information to solve problems (AASL, 2009; Vrasidas & Glass, 2008); as well as new literacies such as online reading comprehension (Coiro, Knobel, Lankshear, & Leu, 2008; Lankshear & Knobel, 2006). Some skills such as critical thinking, and collaboration have always been an outcome of education, it is just that the nature of those skills have changed due to digital technologies making them newly important for students to attain (Dede, 2010; Jenkins, Purushotma, Clinton, Weigel, & Robinson, 2006).

Considering the broad scope and complexity of the term digital literacy, the concept can mean different things to different people. Moreover, the meaning of the term can be vague for novice teachers of technology. A conscious decision was made to use the more concrete term "technology integration" in this study to represent the transformational shift in instructional practice and learning outcomes for students to be successful in a digital world. To clarify, the survey items developed in this study were

informed by the literature around both the concept of digital literacy as well as the literature on technology integration which will be described next.

Technology integration is "the use of technology resources – computers, mobile devices like smartphones and tablets, digital cameras, social media platforms and networks, software applications, the Internet, etc. – in daily classroom practices, and in the management of a school" (Edutopia, 2007). Scholars have proposed different models over the years to identify and/or measure technology integration. Their research has revolved predominantly around two categories. One category emphasizes proficiency in teacher skill level with technology. The second category focuses on pedagogical understanding of technology integration (Lin, Wang, & Lin 2012). These two categories of models will next be described first in theory and then in practice.

Proficiency Models

Theoretically, the proficiency models look at the development of teacher technology integration as stages in a process from novice to expert. SAMR and Levels of Teaching Integration (LoTi) are two examples of the proficiency based stage models. The SAMR model uses four stages, **S**ubstitution, **A**ugmentation, **M**oderation and **R**edefinition as a framework to define the stages of technology integration a teacher progresses through (Puentedura, 2006). At the substitution level, technology acts as a direct tool substitute, with no functional change. At the augmentation level, technology acts as a direct tool substitute with functional improvement. At the modification level, technology allows for significant task redesign, and at the redefinition level, technology allows for the creation of new tasks previously inconceivable. See Figure 2.1 for a matrix of the stages with definitions and examples.

In practice, the SAMR framework is used to facilitate stakeholder understanding of how computer technology might impact teaching and learning (Hogan, 2010, Puentedura, 2006). This framework is presented as proficiency stages

with technology becoming more important in the classroom and yet more seamlessly interwoven into teaching and learning activities. The Maine Learning Technology Initiative, a pioneering 1:1 laptop program, used the SAMR model as a conceptual framework for helping stakeholders understand what teaching in a 1:1 laptop school should look like (Hogan, 2010, Puentedura, 2006). Although the SAMR framework is

Figure 2.1. The SAMR Model

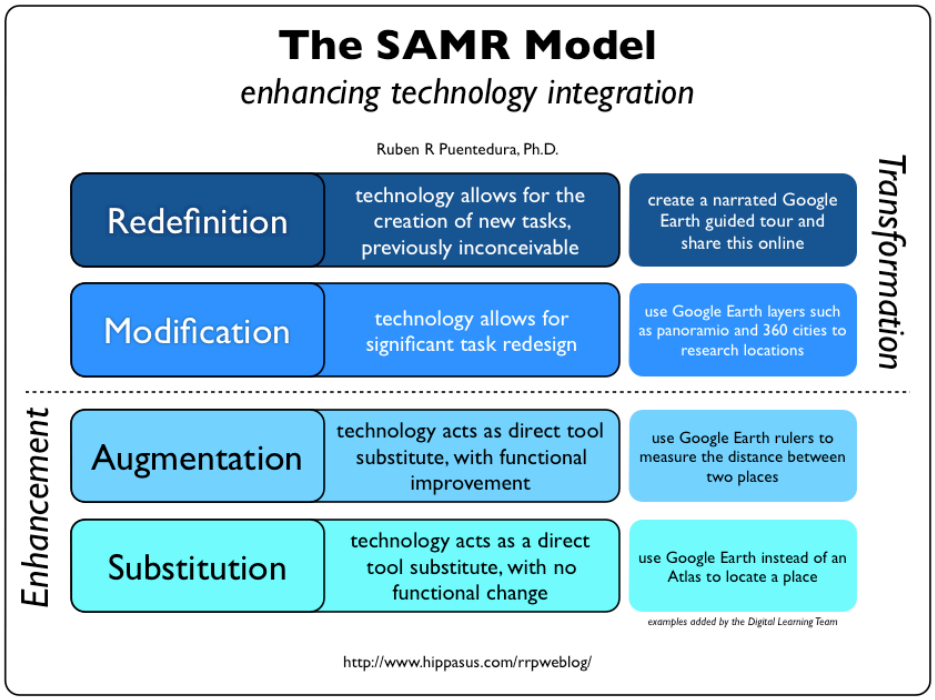

Figure 2.1. Conceptual framework of the four stages of technology integration with definitions and examples. Adapted from Puentedura, R. R. (2006). Transformation, technology, and education. Retrieved August 30, 2015 from http://hippasus.com/resources/tte/

helpful for conceptual understanding of the process of technology integration it has not evolved into an instrument for scholarly research.

Similar to the SAMR model, the LoTi framework also describes technology integration in terms of developmental stages in instructional practices (Moersch, 2010). The difference between SAMR and LoTi is that the SAMR model is a

conceptual framework to help teachers understand the process of technology integration whereas the LoTi Framework was created as a way to measure teacher level of technology integration in instruction (Moersch, 1995). In practice, the first version identified six levels of integration. A score of 0 = non-use of technology in practice. A score of 1 = awareness – the use of digital resources are minimal, and/or used by classroom teacher only for presentation of materials. A score of 2 = exploration – digital resources are used by students for activities such as enrichment exercises and information gathering assignments. A score of 3 = infusion – digital resources are used by students and/or teachers to execute teacher directed tasks related to content standards. A score of 4 = integration – the use of technology is integrated into classroom practice as a tool to identify and solve problems. A score of 5 = expansion – more complex, sophisticated, and spontaneous uses of digital resources for in-depth understanding of content standards. A score of 6 = refinement – pervasive use or access to, and complete understanding of advanced digital tools for problem-based learning, inquiry, and communications (Moersch, 1995, Loti Connection, 2015). In 2001 the framework was modified by dividing level 4, integration, into two levels, mechanical and routine. Mechanical integration of technology relied on pre-packaged materials that aided a teacher in student directed learning. Routine integration occurred more naturally with students fully engaged in exploring real-world issues using available digital resources. The target for teachers was to reach the top three levels: integration, expansion, and refinement. Findings from a national survey indicated that as of 2005 less than 11% of teachers who responded were at the three highest levels and 48% were at level 2 or below (Williamson & Redish, 2009).

The LoTi survey is currently used as a research tool by the LoTi Connection consulting services organization. Its purpose is to generate profiles of participants and schools based on three areas, Levels of Teaching Innovation, Personal Computer Use,

and Current Instructional Practices. The consulting group uses this information as formative assessment to design and prioritize professional development on technology integration for schools and districts. The Atkinson County School District is an example of how the LoTi survey is being used. In this case, 81 teachers in the Atkinson County School district in Georgia were assessed and 47% of the participants were on a Level 2 or lower for Level of Teaching Innovation. As a result of these findings, the professional development goal of Student Learning and Creativity was prioritized and consulting services to provide that training were developed.

Although the SAMR and LoTi proficiency based models help with the conceptualization of technology integration, neither take into account the relationship of teacher learning to technology integration. However, the models helped inform the development of the survey in this study and the analysis of data. Ultimately, this study hopes to expand on these models to include the nature and frequency of teacher self-directed learning activities and their relationship to levels of technology integration (RQ3).

Pedagogical Models

The pedagogy/knowledge models focus on the domains of knowledge teachers must acquire in order to integrate technology effectively into their practice. Mishra and Koehler's (2006) Technological, Pedagogical and Content Knowledge (TPACK) model is well-known in this category. TPACK refers to teachers' development of three domains of knowledge, technological, pedagogical and content knowledge (see Figure 2.2). Teachers must understand and develop in all three knowledge areas and most importantly, in all seven intersecting domains, to effectively integrate technology into their instruction.

On the practical level, there have been numerous research studies looking at the TPACK model from a variety of perspectives. A literature review by Gur and Karamete (2015) summarized 116 articles on TPACK and discussed their findings.

One finding was that most intervention studies produced positive outcomes on teacher TPACK knowledge, especially in the Technology Knowledge (TK) domain. A second finding was that the growth of proficiency in each TPACK knowledge construct did not automatically increase the educator's overall TPACK knowledge. A third finding was that teachers' level of TPACK was related to self-confidence in technology, pedagogy and content. Lastly, the researchers suggest that the TPACK framework be used as a general guideline for future research in how to integrate TPACK into teacher training programs.

Figure 2.2 TPACK Framework

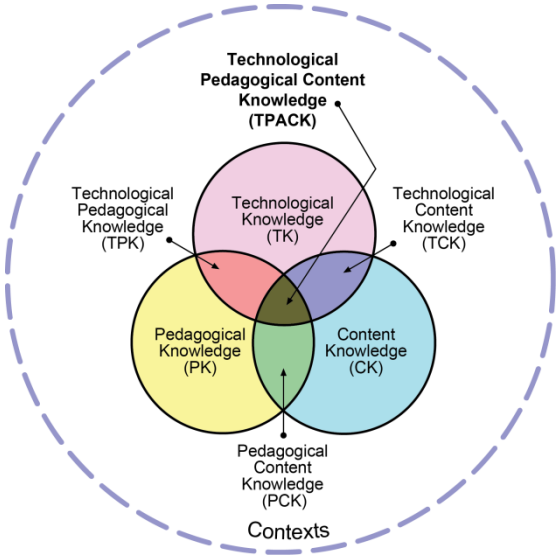

Figure 2.2. Conceptual representation of the three types of knowledge: technology, pedagogy, and content, and their 7 intersecting knowledge domains. Adapted from Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record, 108*(6), p. 1025.

In fact, Mishra and Koehler, the original researchers of the TPACK model, have used it as a conceptual framework to help pre-service and in-service teachers understand the pedagogical changes necessary for technology integration. Their initial case studies revealed that teacher technological proficiency changed while they were in a seminar to design an online course (Koehler, Mishra, Hershey & Peruski, 2004).

Their subsequent work focused on how TPACK developed through teacher participation in different design-based activities such as the development of an online course, educational website, or educational movie (Koehler & Mishra, 2005; Koehler, Mishra, & Yahya, 2007). Although these qualitative studies were helpful in understanding teacher technology integration, they were time consuming. In response, the researchers developed a 35 item survey to measure the essential elements of learning by design (Koehler & Mishra, 2006). This survey was used in a study of teachers in a design-based professional learning course and was administered at various intervals to measure teacher development of TPACK. Participants who were part of design teams showed a significant shift toward developing TPACK.

In sum, the significant contributions of the TPACK model are that:

> The TPCK framework allows us to tease apart some of the key issues that are necessary for scholarly dialogue about educational technology. Our model considers how content, pedagogy, and technology dynamically co-constrain each other. Additionally, we show how the TPCK framework can be used to design pedagogical strategies and an analytic lens to study changes in educators' knowledge about successful teaching with technology. (Mishra and Koehler, 2006, p. 1046)

The TPACK framework and resulting research studies have informed the development of this study as well.

I have just described two categories of technology integration models, the proficiency model as illustrated by SAMR and LoTi, and the pedagogical model as exemplified by TPACK. Although these models have a substantial place in technology integration literature, some limitations have been identified. For example, the TPACK model has been criticized because it leaves out the learning context such as logistics, setting, and how adults learn (McGrath et al., 2011). Another criticism is that the LoTi survey and the SAMR and TPACK models use language of tech savvy experts. As a result, they may use wording that does not take the novice's perspective into account. This scenario tends to create problems with comprehension because experts who have built up knowledge tend to use terms routinely without full awareness that they are

using them (Gorazon, Ennels, & Hammeron as cited by McGrath et al., 2011). For example, in the SAMR model, the *augmentation* level is stated as "Technology acts as a direct tool substitute, with functional improvement" (Puentedura, 2006). The meaning of this phrase is unclear because there is no context given.

Researchers have responded to the limitations of these existing frameworks by building their own models for technology integration. Lin, Wang, and Lin (2012) proposed a two dimensional pedagogy-oriented model that was intended to better depict the complex set of knowledge and skills teachers need to integrate technology into practice. In essence, they were trying to describe the TPACK knowledge domains more fully. Using a multiple case study design, they identified eight levels of technical competency that went from 0 = non-use to 7 = implementation of sophisticated instructional systems. Related to technology competency, four levels of pedagogical competency were proposed: direct teaching, cognitively active learning, constructive learning and social learning. From the analysis of data collected through classroom observation and frequent interviews, they developed the Technology Integration Standards Configuration Matrix. In practice, this matrix was used to locate teachers' individual positions on it allowing teachers and other stakeholders the ability to determine a suitable progression path to integrate technology in more sophisticated ways.

Javeri & Persichitte (2007) developed another type of tool to identify teacher level of technology integration, the Innovative Component Configuration Map (ICCM). Informed by the literature on technology integration models, they designed a survey instrument using word picture descriptions to measure six distinct aspects of technology integration. The resulting matrix was used as an evaluation tool to measure teacher level of technology integration and as an implementation guide for technology in schools.

To add to the research base on teacher technology integration practices, this study attempted to develop a simple framework for measuring depth of technology integration through short answer survey responses. Teachers were asked to describe a time that they felt proud and accomplished in the use of technology in their practice. This process enabled me to use the words of teachers to determine depth of technology integration rather than the prescribed language of the models. The development of the survey and framework for depth of technology integration was informed by the literature discussed in this chapter. The results of this process helped answer RQ3 – what is the relationship between SDL activities and depth of technology integration.

Chapter Summary

As the pressure builds to transform education to better prepare students for success in a technology-infused world, the integration of digital literacy skills and technology into teaching and learning is a priority. Teacher continuous professional learning is critical to achieving this goal. Current dissatisfaction with formal professional development for technology integration has prompted an interest in teacher informal learning practices. Moreover, the potential of self-directing one's own learning using online resources and digital tools is gaining attention. The SAMR, LoTi, and TPACK models are conceptual frameworks that help us understand the process and pedagogy of successful technology integration. These frameworks informed the development of the survey instrument for this study.

The purpose of this study was to address the absence in research on teacher informal learning activities for technology integration. In addition to an exploratory survey study on the nature and frequency of teacher learning activities for technology integration, a new way to measure teacher depth of technology integration was attempted. Further relationships between depth of technology integration and informal learning activities were examined. The findings from this study contribute to our

understanding of teacher informal learning behaviors and inform both teachers and professional developers new ways to provide more effective supports for teacher continuous learning of educational technology.

CHAPTER 3

Methodology

Introduction

This section outlines the methods used in this study. I will present the details of the research design including the sampling method, development of the survey instrument, data collection procedures, and the data analysis strategies used to answer the research questions.

Research Design

This study used an online survey to explore the nature and frequency of self-directed learning (SDL) for teacher technology integration. A major focus was to examine teacher offline and online informal learning activities for technology integration in practice. Offline learning activities are those that are done without the use of digital technology. They could be face to face learning with others or learning on one's own. Online learning activities are those mediated by technology such as computers, mobile devices, Internet resources, and through interactions on social media sites. This study also looked at the relationship between the contextual factors of learning goals and teacher characteristics (demographics) to engagement in informal SDL as well as the relationship between teacher level of technology integration and engagement in informal SDL.

Sampling

The sample of teachers in my study was purposively selected to meet the criteria of teachers in the first or second year of a 1:1 device program or a BYOD program at their school. Since teachers in these kinds of schools were being encouraged to learn and use technology in their practice, exploring their patterns of self-directed informal learning behavior would be relevant. I selected schools in the state where I live for convenience and I chose high schools because that is the education level and context I am professionally most familiar with.

Through word of mouth and by investigating district websites, I found eight high schools that fit my criteria. Through email, I introduced myself and my research study to the principals and technology directors of these schools. Four principals replied that they were interested in speaking further with me. I visited two principals in person at their schools to tell them more about my study and invite them to participate. I spoke to a third principal on the phone and he suggested I meet with the assistant superintendent of the district. I arranged a face to face meeting with her at the district administration office to introduce her to my study. The fourth principal ended up not responding to any of my follow up emails. In the end, the three schools I visited gave me permission to survey their teachers. A description of the demographics of each school and their approach to teacher professional learning of technology follows.

School 1 is a mid-sized suburban high school. According to 2010 U. S. Census data, the total population of the city is 17,936 with 8 % minority. The median household income from 2009-2013 is $57,265 and 12.1% of the residents live in poverty. Based on data from the 2012-2013 school year (U.S. News and World Report, 2015), this school has a student enrollment of 941 students and 94 full time teachers. Fifteen percent of the student body is minority and 26% of the students qualify for free or reduced lunch. On the New England Common Assessment Program (NECAP) high stakes standardized test, 85% of the students scored proficient or better

in reading and 42% in math. School 1 is a BYOD school and chose this type of 1:1 device program for its cost effectiveness. Teacher training for technology integration has been minimal. A four day professional learning program in collaboration with a nearby school was planned for the 2014-2015 school year, the school's second year in a BYOD program. However, a lack of organization with the partnering school combined with poor communications with teachers caused confusion and low levels of participation. For technology training and staff support, there is one Educational Technology Systems Coordinator who serves the whole district. The district technology website offers links to resources, technology support, blended learning, and professional development opportunities. After speaking with a couple of teachers at this school, they indicated that they would like to be included in the professional learning planning process, have better communication about training, and more technical support to handle multiple kinds of devices in a classroom.

School 2 is a small regional high school consisting of two towns that are on the fringe of rural. Using 2010 Census data, the population between the two towns is comparable; 6,135 in Town A and 6,425 in Town B. Town A has a minority population of 4%, the median household income is $78,438 and the poverty rate is 6.3%. In Town B, the demographics are similar with 4% of the population minority, median household income at $81,591, and a slightly higher poverty rate of 9.1%. School 2 has a student enrollment of 567 students with 57 full time teachers. The total minority student enrollment is 5% and 14% of the students receive free or reduced lunch. For student academic achievement in the 2012-2013 school year, 93% of the students were proficient or better in reading, and 61% were proficient in math on the NECAP tests (U.S. News and World Report, 2015). School 2 issued district provided Chromebooks to all high school teachers and students in grade 9 and 10 at the beginning of the 2014-2015 school year. Virtually no feedback from teachers was obtained during the planning and implementation of the program and teacher training

was minimal. Although there is an IT Support Specialist serving the district, this position is more to troubleshoot hardware issues than help integrate technology into teaching and learning. The district technology department has a webpage with links to resources and other information about 1:1, Chromebooks, and Google Apps for education. Information about professional training was limited to a link to the Google training center and to a short list of Google apps available by content area.

School 3 is a large suburban high school located in a town with a population of 30,639 as reported in the 2010 U.S. Census. Eight percent of the population is minority, the median household income is $73,780 and the poverty rate is 6.6%. Student enrollment at the high school is 1,095 with 102 full time teachers. Fourteen percent of the students are minority and 17% of the students qualify for free or reduced lunch. On the NECAP standardized tests taken in the 2012-2013 school year, 90% of the students were proficient or better in reading and 64% were proficient or better in math (U.S. News and World Report, 2015). In the 2014-2015 school year, School 3 piloted a 1:1 district provided laptop program with four teachers. Although all teachers received laptops, only students in the model teacher classes had access to devices. Their 1:1 implementation program was developed with feedback from teachers, parents, and other stakeholders in the community and is being gradually phased in. A full-time Instructional Technology Coach position was added at the high school to support teachers with training. In addition, the model educators facilitated professional learning after school and during faculty meetings for their colleagues. The Instructional Technology Coach has a website with links to sign up for PD facilitated by teachers, technology and instructional resources, and a place to make an appointment with her for help. In 2015-2016 the second phase of the implementation plan was scheduled to go into effect with all 9th and 10th graders receiving Dell laptops.

There were a total of eight high schools in Rhode Island that were in their first or second year of 1:1 device programs in the 2014 – 2015 school year . Table 3.1

summarizes demographic data about all eight schools from the 2012-2013 school year (U.S. News and World Report, 2015). The three schools that participated were representative of all eight schools in the state as a whole who were implementing 1:1 device programs. For example, the percent of students in my sample who were minority ranged from 5% - 15% and ranged from 5% - 18% for the other five schools. The range of students who qualified for free and reduced lunch in my sample ranged from 15% - 26%, and even though the range of the other five was wider at 6% - 39%, the sample range fell centrally within it. In terms of student achievement, students from the schools in my sample who scored proficient or better on the NECAP standardized reading test ranged from 85% - 93%, similar to the range of the other five schools at 82% - 95%. Likewise, on the NECAP math test, students in my sample schools who scored proficient or better ranged from 14% - 26% which falls within the range of the whole group at 6% - 39%. Based on this data comparison, I argue that the three schools in my sample fairly represent the whole group of schools in Rhode Island implementing 1:1 device programs. Therefore, the results from this study could be transferable to other schools in the context and setting of early 1:1 device programs.

Table 3.1

Demographics of Rhode Island High Schools in Early Adoption Stages of 1:1 Device Programs

School #	Device Program	Student Enroll-ment	% Student Minority	% Student Free and Reduced Lunch	Full time teachers	Setting	% Proficient Reading	% Proficient Math	Tech Coach (level)
1	BYOD	941	15	26	94	Large Suburban	85	42	Yes (district)
2	District provided Chome books	567	5	14	57	Fringe Rural	93	61	No
3	District provided Dell	1095	14	17	102	Large Suburban	90	64	Yes (school)

	Laptops								
4*	District provided Chrome books	982	18	39	80	Large Suburban	82	35	No
5*	District provided Chrome books	1694	5	28	138	Large Suburban	89	38	Yes (district)
6*	District provided Chrome books	766	15	6	51	Large Suburban	95	70	Yes (school)
7*	District provided Macbook Airs	1136	6	22	77	Fringe Rural	90	48	Yes (district)
8*	BYOD	974	8	11	78	Large Suburban	88	56	No

Note. *High schools that did not participate in this study.

Instrument Development

The survey was developed using the tailored design method. Tailored survey design "involves using multiple motivational features in compatible and mutually supportive ways to encourage high quantity and quality of response to the surveyor's request" (Dillman, et al., 2009, p. 16). The goal of this holistic design method is encourage responses by appealing to a social exchange perspective on human behavior (Dillman et al., 2009). In other words, the survey should be tailored to appeal to the respondents by making them feel as if their response is important to our understanding of an issue that is important to them, as well as to the larger profession. I used three motivational features to tailor the survey to appeal to my specific sample of teachers. First, I appealed to them to help improve teacher training for technology integration. They were members of schools that were implementing mobile device programs and were experiencing the pressure to learn to integrate technology. I presented the

purpose of the survey was to find out from them how to improve teacher training for technology. Traditional professional development has not been proven to work and their responses would help schools and districts develop more effective training. A second motivational feature was that I tried to keep the survey as short as possible and to administer it in the beginning of the year because teachers do not have a lot of free time and get busier as the year progresses. A third motivational feature was to provide a relevant incentive for those who completed the survey. Through the generosity of my major professor, I was able to conduct a raffle in each school for those teachers who participated in the survey. The winner received a tuition free spot at a premier summer learning event for digital literacy.

The instrument designed for this survey was named the Teacher Learning Activities for Technology Integration (TLATI) survey and consisted of scaled, categorical, and open-ended questions. There were thirteen questions on the survey. Seven questions were closed-ended and six were open-ended. The constructs of the survey were informed by five sources: (a) a review of the literature on SDL, (b) a review of the literature on digital literacy, (c) a review of the literature on teacher professional development for technology integration, (d) a review of the literature on teachers and technology integration, and (e) interviews from a convenience sample of three teachers from a high school not directly involved in my study but who were in the first year of a 1:1 environment. Four constructs of interest were identified through these means. These are:

1. Demographic factors
2. Informal learning activities (both offline and online)
3. Learning goals for technology integration
4. Experience with technology in practice

The steps to develop the survey were: (a) interview teachers to get an idea of the kinds of learning activities they engage in, to hear them describe their level of technology integration in their practice, and to flesh out any general issues; (b) brainstorm and refine a list of items for the closed-ended questions informed by my experience and the literature, (c) develop the open-ended questions, (d) create the online survey, (e) ask four experts to judge the content and format, and (f) pilot test the survey and gather feedback from respondents to further modify the instrument for clarity and purpose.

To begin the survey design process, I interviewed three teachers at my school to get a feel for the kinds of informal learning activities they engaged in and to hear them describe how they integrate technology into their instruction. I chose these teachers because of their experience and that fact that they were in a context similar to my sample. These teachers were known for being tech savvy in their own practice yet they had experience working with teachers who had low tech skills. Two of them had been appointed "Model Educators" at my school as part of our 1:1 laptop implementation program. Their job was to be a technology resource for teachers in their department by sharing tips and tricks and providing training. The third interviewee was an English Department chair. She is known to be an innovative user of technology and would collaborate with teachers in her department to help them implement technology in a meaningful way. Since my school was in the first year of a 1:1 laptop program, they were speaking from a context similar to the survey sample. A description of the interview process is provided next.

An informal conversational interview strategy was combined with an interview guide approach (Patton, 2002). The benefit of the informal conversational interview method is that it offers the flexibility to pursue information in whatever direction appears to be appropriate, yet by using an interview guide, I made sure that I asked key questions to everyone. I was sensitive to the interviewees' time so I made sure to

schedule the interviews at a convenient time for them. One interviewee was a science teacher whom I have known for 10 years and have collaborated with in my role as the library media specialist. I interviewed her during one of her unassigned blocks at school to make it convenient for her schedule. The second interviewee was a health and PE teacher who was in her first year at the school but I had interacted with her through our school's 1:1 initiative program. I interviewed her at school after hours because it worked best for her schedule. I interviewed the third teacher while the two of us car-pooled home after work one day. She lives near me and it was an efficient use of her time. Each interview lasted about 30 minutes. The interview protocol was very informal. I had developed a list of questions that was meant just to get the conversation going. Samples of the questions were: "Tell me how you use technology in your classroom now" and "How did you learn it?" I received their permission to record the sessions so I could refer to them for review. After years of deep reading of the literature on my subject and then acquiring first-hand knowledge from teachers about their experiences and issues, I was ready to create the survey items.

The next step was to develop the close-ended survey questions. Seven questions were developed in all. The first three questions were categorical questions that asked respondents about their years of teaching experience, primary subject matter taught, and gender. Years teaching experience consisted of six categories: 1st year, 2 -5 years, 6 – 10 years, 11-15 years, 16 – 20 years, and over 20. Primary subject matter taught consisted of 12 categories: English, Science, Math, Social Studies, World Languages, Guidance, Art/Music, Health/PE, Special Education, Business/Technology, Library, and Other. The gender question was a two level categorical question with options to check either Male or Female. The purpose of these questions was to gather demographic data on the respondents that I refer to in this study as teacher characteristics. The data on teacher characteristics would then be

used to answer RQ2 – is there any relationship between teacher characteristics and informal learning?

The fourth close-ended question asked participants to indicate the priority they placed on specific learning goals for technology integration during the past twelve months. This question was based on a 4 point scale with 1 = not a priority, 2 = low priority, 3 = medium priority, and 4 = high priority. To create these items, I first brainstormed an exhaustive list of learning goals based on my experience and readings. Since there were so many items, I needed a way to reduce and categorize them. My first attempt was to see how the learning goals aligned to the three types of knowledge for teacher integration of technology in Mishra and Koehler's (2006) TPACK model. I read through the items and marked whether they fell under Technological Knowledge, Pedagogical Knowledge, or Content Knowledge. The majority of the items aligned to multiple TPACK knowledge domains which ended up making sense to me because Mishra and Koehler propose that the highest level of technology integration is when all three knowledge domains intersect. My next step was to organize the items categorically. I inductively came up with five themes: (a) Classroom Instruction, (b) Organization, (c) Collaboration and Communication, (d) Personal Productivity and (e) Student-centered Pedagogy. To reduce the number of items in each category, I then combined some of the related items under a common term. For example, instead of listing tools and programs separately such as Word, email, and electronic grading systems, I listed them as examples under one item which read "tools to increase my productivity such as Word, email, electronic grading systems." In order to make the survey as clear and easy to understand as possible, I used this pattern of identifying a learning goal and following it with a list of possible examples for each item. Another example of this item development strategy is "video chat tools such as Skype, Google Hangout or iChat." The purpose of this question was

to collect data on learning goals and help answer RQ2 – Is there any relationship between teacher learning goals and informal learning of technology integration?

The fifth and sixth close-ended questions asked respondents to indicate how frequently they engaged in specific offline and online informal learning activities during the past school year. These questions were based on an 8 point frequency scale: 1 = never, 2 = once a year, 3 = several times a year, 4 = once a month, 5 = several times a month, 6 = weekly, 7 = several times a week, and 8 = daily. I made the decision to quantify the frequency more specifically to increase the validity of the responses. The downside to a longer list of answer choices is that it can be tiresome and difficult for the respondent to read through or remember all of them for each item (DeVellis, 2012). Although using the terms "infrequently," "frequently," or "very frequently" would simplify the number or answer choices, those terms may mean different things to different people. I chose to increase the validity of responses by using more specific answer choices.

The offline and online learning activity items were developed in a similar fashion as the learning goal question. I first made an exhaustive list of learning activities based on my experience and readings. I then used my theoretical perspective of social-constructivist learning to organize the items into categories. Offline and online learning activities were separated, and then they were categorized under either "social" or "constructivist." I then reviewed the items for clarity and/or redundancy and was able to reduce the number to a total of 25. The purpose of these questions was to answer RQ1, what is the nature and frequency of informal learning activities? See Table 3.2 for a summary of the categories and items.

Table 3.2

Informal Learning Activity Items Aligned to Socio-Constructivist Theory

Theoretical framework	Offline informal learning activities (Q9)	Online informal learning activities (Q10)

Social	1. Asked a colleague in my school of district for help 2. Asked an "expert" outside of my school or district for help 3. Asked a student for help 4. Met F2F with a group to talk/share ideas for technology integration 5. Asked someone at home for help 6. Observed a colleague teaching	1. Emailed a colleague in my school or district for help 2. Emailed an "expert" outside of my school or district for help 3. Posted a question to a professional listserv 4. Read and/or posted information on a social media site 5. Connected with a group online with similar interests 6. Twitter chat
Constructivist	1. Read print books/journal articles 2. Kept a print journal/notes 3. Collaborated with a colleague on a lesson 4. Practiced running through lesson and tech tools before class 5. Created "cheat sheets" to help me remember how to do something 6. Redesigned lesson plans to incorporate technology	1. Watched a "how-to" video online 2. Watched videos of educators in practice 3. Searched the Internet for information 4. Taken screen shots to help me remember things 5. Participated in a Webinar 6. Followed an educational blog or newsfeed 7. Read books and/or articles online

Note. Total of 25 items.

The seventh close-ended question was a categorical question. It asked participants to indicate by checking yes or no, whether in the past 12 months they had engaged on their own accord in any formal learning activities specified on a list. There were 9 items on the list as well as a place for "other." The formal learning items were: (a) national professional conference, (b) state professional conference, (c) local professional organization workshop, (d) school or district professional development that wasn't required, (e) graduate level online course, (f) Massive Open Online Course (MOOC), (g) traditional face to face graduate level course in a degree program, (h)

traditional face to face graduate level course as a non-matriculating student, and (i) unconference.

These formal learning experiences represented a range of formal learning with traditional graduate level courses in a program as the most formal, and unconference as the least. An unconference is a new format for professional development that is philosophically more informal. The topics are participant driven, there is no set curriculum and there may or may not be a designated leader. However, in this study, unconferences are considered on the side of formal learning because they occur on a set date at a set location and there is usually a sponsoring organization. Collecting data on teacher participation in a range of formal learning activities, will help answer RQ1a – Is there any relationship between formal and informal learning for technology integration?

Once I made progress developing the close-ended questions, I moved to the third step of the survey design process and began to consider the focus and wording of the open-ended questions. The purpose of the open-ended questions was to elicit more granular information from the respondents that would support, clarify in more detail, and expand on the important constructs being studied, namely depth of technology integration, SDL experiences, and learning goals. The drawbacks of open-ended questions are that they ask for more investment of the respondents' time and they take more time to for researchers to analyze. I felt however, that the following four benefits outweighed the drawbacks. One benefit was that the data from the open-ended questions could be triangulated with the data from the close-ended questions. Second, the open-ended questions would provide more detail and elaborations on the constructs. Third, the use of open-ended responses addressed the issue of comprehension. Teachers who are novice users of technology may not potentially comprehend high tech terms used in close-ended questions. This benefit would increase the validity of the data. Fourth, open-ended questions could minimize the

tendency for teacher self-report bias on surveys, particularly in terms of technology skill level (Kopcha & Sullivan, 2007). Six open-ended questions were included in the survey. The questions were informed by my readings and experience, their importance to the study topic, and by suggestions from my dissertation committee.

The first open-ended question asked participants to identify three learning goals that they would prioritize for the next year. They were instructed to use the list from the previous close-ended question on learning goals or to add their own. The purpose of this question was to find out using respondents' own words what they were going to prioritize as future learning goals. The results from this question would be used to triangulate the data from the close-ended question on learning goals and elicit further description of learning goals. The data from this question was important because it would help answer RQ2 – Is there any relationship between learning goals and informal learning of technology integration?

The second open-ended question asked teachers to think of themselves as a learner of technology. They were asked to describe "what have you learned in regards to technology and teaching that has given you a sense of accomplishment? Why and how did you learn it?" The intent of this question was to elicit stories from the respondents as a proud learner of technology integration. The data from this question would provide more detail and contextual information on teachers as learners as well as be triangulated with the data on learning goals and learning activities. In effect, this question would support answering RQ2 – Is there any relationship between teacher learning goals and informal learning of technology integration?

The third open-ended question asked respondents to think of themselves as teachers in practice. They were asked to "Please describe a time when you were pleased with the way you integrated technology into your teaching." The purpose of having them write their response for being a proud teacher would be used to identify teacher level of technology integration. One goal of this study was to try and identify

teacher level of technology integration using the words of teachers, not technology experts. This was a very important question because its purpose was to provide a way to score depth of technology integration and answer RQ3 – Is there any relationship to informal learning and depth of technology integration?

The fourth open-ended question asked participants to think of themselves as a learner and to finish the sentences "If I wanted to learn more about using a new and unfamiliar technology tool in my practice, I would first…, then I would…I would definitely not…" This open-ended question asked them to describe their "go-to" learning activities and to identify activities that they would not do to learn about technology. The purpose of this question was to elicit more detailed information on their informal learning activities which would help answer RQ1- What is the nature and frequency of informal learning activities for technology integration?

The fifth open-ended questions asked respondents: "Do you have any favorite online resources that help you integrate technology into your teaching? If so, please list below and include a short description of how or why you use it." The purpose of this question was to explore online learning activities in more detail. Identifying online learning activities is of special interest in this study and would therefore help answer RQ1 – What is the nature and frequency of informal learning activities for technology integration?

The sixth and last open-ended question asked teachers to "Please use this opportunity to share your ideas about the kinds of supports, resources, and learning experiences that would help you best learn to integrate technology into your teaching." I included this question because it not only could help answer RQ1 with more detail, but this question was true to the mission of the tailored survey design method. The intent of this question was to make respondents feel important by appealing to them as experts on informal learning of technology integration and that their suggestions would contribute to this study and profession on a larger scale.

Once I had my questions developed, I moved to the fourth step and created the instrument using Survey Monkey, an online survey generating program. I selected this program because it has appropriate features for my use, I am familiar with it, and I had access to it. For instrument layout, I referred to the design principles from Dillman et al. (2009) and paid particular attention to the wording and format to make sure the survey was consistent, visually appealing and easy to understand. There were seven pages in the survey with the first page devoted to the Informed Consent Letter. Respondents were advised to print the letter if they wanted, and told that their consent was officially given if they hit the "next" button to proceed. Since teachers do not have a lot of time, a progress bar was added to the survey to give them a sense of the time involved. Respondents were not required to answer every question and they could opt out at any time. A simple, clean design style was used to minimize distractions. Attention to spacing and layout was given to make it easy to read and to project a professional tone.

When the online survey was ready, I moved to the next step of asking a group of experts knowledgeable in the field to review the survey for content and clarity (DeVellis, 2012). Content-related reliability evidence ensures instrument validity and increases confidence that the instrument is measuring what it is intending to measure (Fraenkel et al., 2012). The experts I asked were: my major professor, a technology integration specialist at my school, a principal in a school where teacher PD for technology is a high priority, and a professor at URI who teaches in the Graduate School of Library and Information Studies. The most common constructive criticism was to reduce the number of words in each question because general consensus was that teachers do not have time to take long surveys. Using their feedback, I made modifications as necessary. At this point I was ready to pilot the survey.

During October of 2014, I piloted the survey using the cognitive validation interview method. Beatty and Willis' (2007) definition of cognitive validation is "to

generate verbal information that is usually unseen in a survey interview in order to evaluate how well the questions are meeting their objectives" (p. 292). Researchers have approached this method from two paradigms. One is the pure-think aloud interview where the researcher's role is simply to listen to what the interviewees say they were thinking while answering the survey questions. The second method, the probing interview, allows the researcher to ask questions about comprehension. I used both the think-aloud and the probing interview methods.

Four teachers were interviewed as part of the cognitive validation process. These teachers were selected for convenience and for their diverse demographic characteristics and differing comfort with technology. I used the pure think-aloud method for the first two teacher interviews. The first teacher was a female Social Studies teacher with better than average technology skills and over 12 years of teaching experience. The second was a female math teacher with five year of teaching experience and above average technology skills. For these interviews, I simply asked them "what do you think this question is asking?" and listened and took notes. Common issues were immediately brought to light. For example, the item "participated in an informal professional learning community" was unclear for the first two interviewees. Using the probing interview method with the second two teachers, I took their ideas into consideration and modified it to "met face to face with a group to talk/share ideas for technology integration." The first teacher interviewed in the probing method was a professor at the URI Graduate School in Library and Information Studies (GSLIS) with three years of teaching experience and high technology skills. I knew this professor from my work as a part-time lecturer for GSLIS. The fourth interviewee was a male English teacher at my school with 17 years teaching experience and low tech skills. I began the interviews asking them what they thought the question was asking, and then I continued with some additional questions to clarify and get more information on their comprehension of the survey and to elicit

feedback on better ways to phrase the questions. All of the interviews took about 30 minutes each and I recorded notes on a printed version of the online survey. Finally, I refined the survey questions once again based on this information.

Data Collection Procedures

Now that the survey instrument was ready, I put together a timeline for implementation which can be seen in Table 3.3.

In November, I introduced my study to the teachers at the three schools in my sample. At two of the schools, I attended their monthly faculty meeting. The principal put me on the agenda and I took about fifteen minutes to tell them about the purpose of my study and what I was asking them to do. I explained the consent letter, how the online survey would work, and the timeline for the survey window. I clarified that their answers would be strictly confidential and would in no way affect their job or pay. I also stated that Survey Monkey would be set up to track who responded so I could conduct the raffle, but would not attach emails to responses which would ensure a level of anonymity. I told them that the survey was completely voluntary, they could stop answering at any time, and the estimate to complete it was 20 minutes. I ended by fielding questions and was pleased to see that they seemed interested in participating. The third school did not have a faculty meeting that month so I composed a letter with similar information about the survey and the principal of the school put the letter in the teachers' mailboxes.

Table 3.3

Timeline for Survey Implementation

October 2014	November 2014	December 2014
• Pilot survey • Make modifications based on feedback	• Visit schools to introduce study • Send email invitations • Open survey window for two weeks • Send two reminder emails	• Close survey window

I used Survey Monkey to administer the online survey and collect the data. To prepare for the actual implementation of the survey, I entered the email addresses of all the teachers which I obtained from the schools' websites. I created a separate collector for each school so I could compare response rates between the schools to determine if I had even representation. Then I created a schedule for the survey window to open and close. I also generated invitation and reminder emails and set-up a timeline for their release. Within a day of introducing my survey to the teachers, email invitations were automatically sent from Survey Monkey. A reminder email was sent after approximately five days after the survey window opened and another one was sent three days before the close of the survey. I set up Survey Monkey so that only the teachers who had not responded would receive the reminder emails.

Non-response error was a threat to my study which I minimized by using the tailored design method (Dillman et al., 2009). I customized the survey to the audience by providing concise and easy to understand descriptions to questions. I also appealed to their sense of wanting to help improve teacher learning of technology to better prepare their students with the necessary skills to be successful citizens in today's digital world. A summary of the steps I followed to encourage response were: (a) introduced myself and explain the importance of the survey in person at a faculty meeting or in a letter to each teacher; (b) included a note in the email with the survey link that expresses the importance of their participation and my appreciation for their help; (c) followed-up with a reminder email five days after the survey window opened and again three days before it closed; and (d) offered an incentive: the chance for one respondent from each school to win a tuition free spot at a premier summer professional learning program in digital literacy.

Throughout the development of the survey I was controlling threats to internal validity. Subject characteristics, survey report bias, and survey fatigue were possible

threats to my study. I controlled for threats to subject characteristics and survey report bias by creating an instrument in which the items were developed using non-biased, descriptive language of both expert and novice teachers. I also communicated that the purpose of this survey was to find out more about their informal learning experiences and that their input would contribute to the knowledge base of informal learning for technology. I minimized survey fatigue by administering the survey relatively early in the school year and by keeping it as short as possible. I also standardized the survey procedure for all sites to minimize location threats to internal validity.

Data Processing and Analysis

After the survey window closed, I downloaded the data from SurveyMonkey into both an SPSS file and an Excel file. I copied these files to create working files and then saved the Master data files on a flash drive locked in a safe location, and onto my password protected Dropbox account as a secondary backup method. Since there were both close-ended and open-ended questions in my survey, I employed both quantitative and qualitative analysis methods respectively. I will next describe the data cleaning procedure, then the quantitative data analysis methods by research question, and conclude with the qualitative data analysis steps.

Quantitative Data Analysis

To clean the data, I used SPSS and ran descriptive statistics for the close-ended questions: Q1, Q2, Q3, Q4, Q9, Q10 and Q12. Unanswered questions were not included in the analysis. The mode was calculated for the demographic data in Q1, Q2, Q3, and Q12. Means, standard deviations, range, and histograms were calculated for Q4, Q9, and Q10. As a researcher, I chose the more liberal measurement perspective of treating the response categories of Q4, Q9, and Q10 as interval scales rather than ordinal scales. Although the response categories were not true interval scales, the

differences between them were meant to be equal. Moreover, the data is meaningful when analyzed on an interval scale and it exhibits characteristics of interval data such as a normal distribution. I acknowledge that there is some controversy about treating ordinal scales as interval scales, but Knapp's (1990) commentary highlights that it is the researcher's prerogative to "choose a measurement perspective" (p. 122). He even quotes S. S. Stevens, a statistical traditionalist, as acknowledging the practicality of treating ordinal scales as interval scales; "there can be invoked a kind of pragmatic sanction: In numerous instances it leads to fruitful results" (p. 123). From this measurement perspective, I analyzed the data by calculating means and standard deviations and created tables in Excel. For the scaled questions i.e. Q4, Q9, and Q10, I sorted the data from highest mean to lowest for clarity in reading. Through this process I was able to verify that the data was clean and look for any unusual data or errors. The quantitative data analysis procedure by research question will be presented next.

RQ1: What is the nature and frequency of teacher SDL experiences for technology integration?

Teacher engagement in offline and online informal learning activities was explored in questions Q9 and Q10. These two close-ended questions used an 8 point scale to measure teacher self-reported frequency of informal learning activities. The scale increments were: 1 = never, 2 = once a year, 3 = several times a year, 4 = once a month, 5 = several times a month, 6 = weekly, 7 = several times a week, and 8 = daily. There were a total of 25 items for this variable as well as a field for "other." Descriptive statistics to test measures of central tendency (mean) and to measure variability including range and standard deviation (SD) were run for the 25 offline and online informal learning activities. The range and histograms were also calculated and the data was entered in Excel and sorted from highest mean to lowest for clarity in reading.

In addition to looking at the learning activities at the granular level, I ran a factor analysis of all 25 items, both offline and online together, to see if any of the items clustered together. Since this research study is an exploration of teacher informal learning for technology integration, factor analysis could help determine any patterns of learning activities by identifying broader themes. To conduct the factor analysis, the Varimax rotation method was used to check for principle components. Internal consistency was determined using Cronbach's coefficient alpha of .600 or higher. The items for informal learning activities loaded onto five principal components: (a) Outward-looking (b) Independent, (c) Online Social, (d) Local, and (e) Traditional. These loaded factors will now be referred to as variables of "Learner Behaviors." The items that hung together for each of these new variables and the Cronbach alpha score for each item follows.

The first new variable, Independent Learner, consisted of three items: (a) searched the Internet for information (α = .803), (b) read books and/or articles online (α = .713), and (c) practiced running through lesson and tech tools before class (α = .713).

The second new variable, Local Learner, consisted of four items: (a) asked a colleague in my school or district for help (α = .755), (b) asked a student for help (α = .736), (c) collaborated with a colleague on a lesson to integrate technology (α = .687), and (d) emailed a colleague in my school or district for help (α = .677).

The third new variable, Traditional Learner, consisted of three items: (a) kept a print journal/notes (α = .714), (b) read print books and/or articles (α = .660), and (c) observed a colleague teaching (α = .634).

The fourth new variable, Outward-looking Learner, consisted of four items: (a) emailed an "expert" outside of my school or district for help (α = .781), (b) watched videos of educators in practice (α = .731), (c) asked an "expert" outside of my school or district for help (α = .668), and (d) watched a how-to" online tutorial (α = .624).

The fifth new variable, Online Social Learner, consisted of three items: (a) twitter chat (α = .788), (b) followed an educational blog or newsfeed (α = .738), and (c) connected with a group online with similar interests (α = .674).

Means and standard deviations were calculated for each of the new learning behavior variables.

RQ1a: What is the relationship between formal and informal SDL experiences?

To answer RQ1a, I looked at Q12 which asked participants to indicate if they had participated in any formal learning activities on their own accord during the past 12 months. There were nine items in this question and a place for "other." The nine items were: (a) National professional conference, (b) state professional conference, (c) local professional organization workshop, (d) school or district professional development that wasn't required, (e) graduate level online course, (f) Massive Open Online Course (MOOC), (g) traditional graduate level course in a degree program, (h) traditional graduate level course as a non-matriculating student and (i) unconference. The items were scored 0 = no, and 1 = yes. The nine items were summed into a new variable called Formal Learning. The mean and standard deviation for Formal Learning is reported in Table 3.1. Regression analysis using the enter method, the standard method of entry, was conducted to examine if any of the learner behaviors predicted engagement in formal learning. In the standard method of entry all independent variables are entered into the equation at the same time. This is an appropriate analysis when dealing with a small set of predictors and when the researcher does not know which independent variables will create the best prediction equation. Each predictor is assessed as though it were entered after all the other independent variables were entered, and assessed by what it offers to the prediction of the dependent variable that is different from the predictions offered by the other variables entered into the model.

RQ2: How do teacher characteristics and personal learning goals relate to engagement in SDL activities for technology integration?

Teacher characteristics in this study are defined as years of teaching experience, gender, and primary subject area. Years of teaching experience was a categorical question with 1 = first year, 2 = two – five years, 3 = six to ten years, 4 = eleven to fifteen years, 5 = sixteen to twenty years, and 6 = over 20 years. The modes for these are reported in Table 3. The second variable for teacher characteristics, Gender, is a dichotomous variable with 0 = Male and 1 = Female. The variable, primary subject area consisted of 12 categories, (a) English, (b) Science, (c) Math, (d) Social Studies, (e) World Languages, (f) Guidance, (g) Art/Music, (h) Health/PE, (i) Special Education, (j) Business/Technology, (k), Library and (l) Other. Since there were more than two levels to this variable, new dummy coded dichotomous variables would have had to be calculated for use in regression analysis. This process was not done because the number of responses in each category was not large enough for statistical purposes. Therefore, the data from this question was used to validate the sample as representative of larger populations rather than as variables to explore relationships to informal learning behaviors.

Data for teacher learning goals was obtained in Q4 which asked teachers to prioritize their learning goals for technology integration during the past 12 months. This question consisted of 18 items and included a choice for "other" for respondents to write in a response. This question used a 4 point scale. 1 = not a priority, 2 = low priority, 3 = medium priority, and 4 = high priority. In the development of this survey, the items were organized into five categories of learning goals: (a) classroom instruction, (b) connecting, (c) organization, (d) teacher productivity, and (e) student centered activities. The items in each of these categories were summed to reduce the number of learning goal variables in order to see patterns more clearly through regression analysis.

The first category, classroom instruction, included items that focused on instruction and consists of four items: (a) presentation tools for my lessons such as Prezi, PPT or Smart Notebook; (b) instructional strategies such as flipped classes or student centered learning; (c) development of lessons integrating technology and/or digital media, and (d) assessment tools such as Quizlet, Socrative, and Polleverywhere. These four items were summed to create a new variable for learning goals called *Classroom Instruction*.

The second category, connecting, included learning goals related to communicating and collaborating. There were three items in this category: (a) collaboration tools such as Google docs or Padlet, (b) communication tools between student and teachers such as Twitter or blogs, and (c) video chat tools such as Skype, Google Hangout, or iChat. These three items were summed to create a new variable for learning goals called C*onnecting*.

The third category, organization, included learning goals related to teacher organization. There were three items in this category: (a) websites to organize and make class information available such as Edmono, Wikispaces or Weebly, (b) learning management software such as Google Classroom or Aspen, and (c) sites that help me organize and share information such as Pinterest, Symbaloo or Blendspace. These three items were summed to create a new variable for learning goals called *Organization*.

The fourth category, personal productivity skills, included learning goals focused on teacher's personal skills using technology to be more productive. There were three items in this category: (a) tools to increase my productivity such as Word, email, electronic grading systems; (b) screencasting tools such as Jing or Screencastomatic, and (c) digital video editing production tools. These three items were summed to create a new variable for learning goals called *Personal Productivity*.

The fifth category, student-centered, consisted of learning goals that are related to engaging students in their own learning with technology. There are three items in this category: (a) presentation tools (other than PowerPoint) for students to show or demonstrate their learning, (b) mind-mapping tools that students use to develop critical thinking/problem solving skills such as Mindmeister, Inspiration or Popplet, and (c) resources to help me incorporate digital citizenship lesson in my teaching such as Common Sense Media and Edutopia. These three items were summed to create a new variable for learning goals called *Student-centered*.

Once these calculations were completed, regression analysis using the standard enter method was conducted to determine if any of the five learning goals, or the demographics variables of Years of Experience or Gender predicted any of the five informal learning behaviors.

Qualitative Data Analysis

Open-ended survey responses provide multiple advantages to a researcher. They provide qualitative data that is richer in description than the data from the closed-ended question. They also offer greater anonymity to respondents, elicit more honest responses (Erickson & Kaplan as cited in Jackson & Trochim, 2002), capture diversity in responses, and provide alternate explanations to close-ended questions (Huberman & Miles, 1994). Despite the advantages of open-ended survey response questions, researchers acknowledge that they can be challenging to analyze (Jackson & Trochim, 2002). They are typically brief and sparse as compared to interview data, are removed from the context, and can be time-consuming to code. The disadvantages were diminished due to the informative literature on open-ended survey data by Ryan and Bernard (2000) and grounded theory coding by Corbin and Strauss (1990) and Huberman and Miles (1994).

Ryan and Bernard (2000) describe two kinds of qualitative traditions: the linguistic tradition where text is treated as an object of analysis itself, and the

sociological tradition where text is a window into human experience. In this study, my perspective as a researcher fell under the sociological tradition. In the sociological tradition there are two kinds of text, words or phrases and free-flowing texts which are typically responses from open-ended questions. The open-ended responses in this study were characteristic of free-flowing text. The methods I used to analyze the free-flowing text were through word analysis by counting words, and by analyzing chunks of text. Grounded theory, a major coding tradition, informed my method of analyzing chunks of text.

Corbin and Strauss (1990) describe grounded theory as an open coding process where the researcher identifies potential themes by pulling together examples from the text. As a methodological process they state that "The procedures of grounded theory are designed to develop a well-integrated set of concepts that provide a thorough theoretical explanation of social phenomena under study" (p. 5). The concepts therefore, are the basic units of analysis. The tactics I used to code the data were to: (a) proofread and underline key phrases (Sandelowski, 1995), and then I used the following steps outlined by Huberman and Miles (1994): (b) note patterns and themes using color coding, (c) consider plausibility by making seeing if the themes made initial intuitive sense, (d) cluster by conceptual grouping to see connections, (e) count to see frequency of concepts, and (f) make contrasts and comparisons between responses. I also made two kinds of memo notes: code notes to record concepts being discovered and theory notes to summarize what was going on in the text. Memoing is a principal technique for recording relationships among themes (Corbin & Strauss, 1990). These strategies were used to give help give order to the data during the iterative coding process. The following section describes the process of the open-ended questions in more detail, first by looking at the data from Q8 that answers RQ3, and then by looking at the data from the rest of the open-ended questions, Q5, Q6, Q7, Q11, and Q13.

RQ3: What is the relationship between teacher level of technology integration and their SDL experiences?

One goal of this research was to explore a new way to measure a teacher's level or depth of technology integration by having them describe it using their own words. Q8 was an open-ended question that asked participants to describe a time when they were pleased with the way they integrated technology into their teaching. The intent of this question was to hear in their own words what they considered was a high level use of technology integration for them. The purpose of this was to minimize high tech jargon that might confuse or intimidate teachers, especially less tech savvy ones. My plan was to code the qualitative data and quantify it so it could be used as an output variable for regression analysis to answer RQ3.

The qualitative data was inductively coded as follows. First I read through the short answers to look for patterns and broad themes and made notes. After two more readings, I inductively developed three types of criteria to measure the depth of their technology integration. The first criteria concerned the focus of activities they described. Were they teacher centered or student centered? Teacher centered indicated a narrow level of depth and student-centered a broader level. The second criteria focused on the complexity of their experiences. Were they describing use of one tech tool or multiple? Use of single, simple tools indicated a lower level of depth, and the use of more than one tool in a more sophisticated way indicated a higher level. The third criteria involved pedagogical context. Were they describing situations where they played it safe or was there evidence of a transformation of instructional strategies? Teachers who played it safe described using tools as enhancements or replacements to traditional instructional practices and were scored as narrow level. Teachers who described situations where technology was transforming their instruction were scored as broad level. Using this process, I coded the qualitative answers using a score on a continuum of 1, 2, and 3, with 1 being narrow depth for

technology integration, 2 being in the middle, and 3 being the broadest level of depth. Responses that did not make sense such as "depth" and "research and response" were omitted from the sample. The criteria for technology integration are illustrated in Table 3.4.

Table 3.4

Criteria for Measuring Teacher Depth of Technology Integration

Criteria	Narrow = 1	Middling = 2	Broad = 3
Focus	Teacher focused Productivity focused	A combination of Narrow and Broad	Student centered Student choice Authorship/content creation New vision of teaching
Complexity	Single tool Limited use Simple 1 time		Multiple tools Multiple uses Complex Extended time Multiple times
Pedagogical Context	Traditional pedagogy In class Safe		Risky Flexibility Outside class

To help ensure reliability in my coding, I asked a colleague to code the data using the same three criteria. This colleague's title is District Technology Fellow and she is in charge of implementing the 1:1 laptop program at my school. She is knowledgeable about the issues with teachers learning technology, has experience facilitating professional development for teachers, and has worked with both administration and individual teachers to raise the level of technology integration at my school. To ensure inter-rater reliability we scored several of the responses together and discussed our scores and justifications to reach consensus on rating criteria.

Upon completion of individual scoring, we compared our answers, and discussed the ones which we had scored differently to reach consensus. Examples of a

score of 1 were “I'm just glad when videos work” and “I do like having my notes as PowerPoint presentations rather than rewriting them each time. It helps me stay better organized, neater, and more prepared.” These responses indicate a teacher-centered simplistic level of technology use. Examples of a score of 2 were “I like setting up a google doc for the whole class to collaborate on. It's very rewarding to be able to give them immediate feedback on what they are doing” and “Using formative assessment tools like socrative and kahoot.” These responses indicate the teachers are using one or more technology tools in their instruction for specific purposes and are starting to focus on interacting with students. Typical examples for a score of 3 were “Using blogs for current events. Ideas were shared. Opinions were given. Multimedia was presented. Students were taught how to create one. Then they created their own blog tracking an area of interest” and “Again, using our fusion page, the discussion blogs, trying out new tools with the students. These and many other tools no doubt not only facilitate differentiated learning but enrich it. I have been able to maximize the benefits of class time and instruction. For example, while I am teaching and working with one or more students, my other students are learning, interacting by responding to assignments. Prompts, and discussion blogs.” These responses illustrate a more complex use of technology and a broader vision of technology use in the context of instruction. As a result of this coding process, a new quantitative variable, Depth of Technology Integration (TI) was created for statistical calculations. A regression analysis was conducted using the enter method to determine any relationships between Depth of TI with learner behaviors, learning goals, years of experience and gender.

I just described by research question, the data analysis strategies for the close-ended questions and the Depth of TI open-ended question. Next I will discuss the methods used to analyze the qualitative data.

Open-ended questions. I used an inductive coding process to analyze the open-ended questions Q5, Q6, Q7, Q11 and Q13. First, I downloaded the qualitative

data into a master worksheet in Excel. I then created a separate worksheet for each survey question and copied and pasted the qualitative data from the master worksheet onto each individual worksheet. I then printed the worksheets and began a four step coding process.

The first step was an initial read through to see if the answers made sense and to begin to identify common topics or themes through underlining phrases and to hand write notes next to the data indicating first impression topics. Using these notes, I identified 7 - 8 themes that the majority of the data fell into. The second step was to read through the data again and to confirm or reconsider my initial thematic identifications and try and reduce the number of them. I was able to reduce the themes down to 5 or 6. I hand wrote these notes next to the data accordingly. The third step was to color code the data. Each theme was assigned a color and using my notes, I manually went through the data to color code phrases or words that corresponded to each category. The fourth step was to transpose my manual color coding work onto the Excel worksheet. To visually read the data more easily, I put each theme name as the heading of a column in the worksheet and copied the appropriate response into the assigned theme. I shared this coding process with my major professor and justified my coding with examples of each.

In some cases, I quantified the qualitative data by counting the number of times a phrase was coded in each category. For all of the questions, I marked examples of responses in each category. Through this process I triangulated the quantitative data and/or elicited more detail. Further discussion on the qualitative findings will be included the results section.

CHAPTER SUMMARY

I have just described the methods used in this study. I presented the details of the research design including the sampling method, development of the survey instrument, data collection procedures, and both the quantitative and qualitative data

analysis techniques used to answer the research questions. In the next chapter I will report the findings.

CHAPTER 4

Findings

Introduction

This chapter presents the results from both quantitative and qualitative data analysis of teacher self-reported survey responses of their self-directed learning (SDL) activities. The data was collected through an online survey from a purposely selected sample of teachers in 1:1 or Bring Your Own Device (BYOD) schools. These analyses were conducted in an effort to answer the following three research questions:

RQ1: What is the nature and frequency of teacher SDL experiences for technology integration?

RQ1a: What is the relationship between formal and informal SDL experiences?

RQ2: How do teacher characteristics and personal learning goals relate to engagement in SDL activities for technology integration?

RQ3: What is the relationship between teacher level of technology integration and their SDL experiences?

First, I will report on the demographics of the teachers in the sample and then I will report the findings to each research question.

Sample

The purposively chosen sample was high school teachers in schools that were in the early stage of 1:1 (ES1:1) programs. ES1:1 schools are defined as in their first or second year of implementing programs where every student has access to their own computer device. There was a 52% response rate (n = 129) for the total number of invited participants. Response rates from all three schools were comparable. One hundred and twenty-nine people responded but not all of them answered every question. Questions 1, 2 and 3 of the survey pertained to teacher characteristics (demographics): Q1 = years of teaching experience, Q2 = primary subject matter taught, and Q3 = gender. The demographics of the respondents are represented in Table 4.1.

Table 4.1
Teacher Characteristics (Demographics)
Frequency and Percentages of Teacher Characteristics

Years Teaching	*Frequency*	%	n
1st Year	1	0.8	
2-5 years	9	7.0	
6-10 years	20	15.5	
11-15 years	34	26.4	
16-20 years	27	20.9	
Over 20	38	29.5	
Total	129	100	129
Primary Subject Area			
English	20	15.6	
Math	19	14.8	
Science	19	14.8	
Social Studies	18	14.1	
Special Education	15	11.7	
Business/Technology	9	7.0	
World Languages	9	7.0	

Art/Music	6	4.7	
Other	5	3.9	
Guidance	3	2.3	
Health/P.E.	3	2.3	
Library	2	1.6	
Total	128	100	128
Gender			
Male	42	32.8	
Female	86	67.2	
Total	128	100	128

The respondents in this study had more years of experience than the national average of U. S. public school teachers (Feistritzer, 2011). In 2011, 26% of U.S. public schools teachers had 1 – 5 years of experience compared to only 7.8% of the respondents in this study. Similarly, only 40% of U.S. teachers had 15 or more years of experience, whereas 51% of the teachers in this study had 16 or more years of experience. One should to bear in mind that the sample is high school teachers and part of this difference could be due to grade level. A higher percentage of teachers in their first five years are often at the elementary level. The percentage of respondents in each subject matter however, proportionally represented the profile of public school teachers. In terms of gender, the sample was comparable to the US population. Eighty-six percent of the population of U.S. teachers is female compared to 84% in this study.

Discussion of Findings by Research Question

There were a total of five findings as a result of the data analysis. The five findings will be presented next under the corresponding research question.

Research Question 1: What is the Nature and Frequency of Teacher SDL for Technology Integration?

Finding #1. *High school teachers in ES1:1 device programs frequently engage in relevant hands-on informal learning activities supported by interactions with colleagues in their school when learning to integrate technology into practice.*

The nature and frequency of teacher informal learning activities was explored through both close-ended and open-ended survey questions. Table 4.2 provides the findings from the close-ended questions on the individual item level.

Table 4.2
Frequency of Teacher Participation in SDL Activities

Informal Offline Learning Activities	n	Mean (SD)	Range 1-8
Practiced running through lesson and tech tools before class	109	4.92 (1.76)	1 - 8
Asked a colleague in my school or district for help	114	4.88 (1.49)	2 - 8
Redesigned lesson plans to incorporate technology	113	4.35 (1.78)	1 - 8
Collaborated with a colleague on a lesson to integrate technology	113	4.14 (1.97)	1 - 8
Read print books and/or articles	112	4.04 (2.19)	1 - 8
Asked a student for help	111	3.95 (1.52)	1 - 8
Met face to face with a group to talk/share ideas for technology integration	112	3.50 (1.67)	1 - 8
Created "cheat sheets" to help me remember how to do something	112	3.22 (1.82)	1 -8
Kept a print journal/notes	108	3.04 (2.30)	1 - 8
Observed a colleague teaching	111	2.96 (1.81)	1 - 8
Asked someone at home for help	111	2.95 (2.12)	1 - 8
Asked an "expert" outside of my school or district for help	112	2.69 (1.65)	1 - 7
Informal Online Learning Activities			
Searched the Internet for information	111	6.00 (2.00)	1 - 8
Read books and/or articles online	111	4.69 (2.25)	1 - 8
Emailed a colleague in my school or district for help	112	4.01 (1.62)	1 - 8
Read and/or posted information on a social media site	109	3.94 (2.71)	1 - 8
Watched a "how-to" video online	111	3.59 (1.68)	1 - 7
Taken screen shots to help me remember things	111	3.21 (2.17)	1 - 8
Followed an educational blog or newsfeed	110	3.13 (2.32)	1 - 8
Connected with a group online with similar interests	111	2.59 (2.18)	1 - 8
Watched videos of educators in practice	111	2.57 (1.49)	1 - 7
Participated in a webinar	111	2.32 (1.43)	1 - 7
Emailed an "expert" outside of my school or district for help	109	2.11 (1.34)	1 - 6
Twitter chat	109	1.97 (1.84)	1 - 8
Posted a question to a professional listserv	109	1.68 (1.14)	1 - 6
Formal Learning			0 - 1
School or district non-required PD	109	.54 (.50)	
Local professional organization workshop	106	.46 (.50)	
State professional conference	108	.33 (.47)	

Unconference	99	.17 (.37)
National professional conference	108	.15 (.36)
Graduate level online course	105	.12 (.33)
Massive Open Online Course (MOOC)	106	.09 (.29)
Traditional graduate level course (non-matriculating)	106	.07 (.26)
Traditional graduate level course (degree program)	106	.07 (.26)

Note: PD = professional development. SDL = Self-Directed Learning.

On the individual item level, the quantitative data results indicate that teachers are regularly engaging in hands-on, socially constructed offline and online informal learning activities. The response choices for the offline and online informal learning items were based on a frequency scale of 1 = never, 2 = once a year, 3 = several times a year, 4 = once a month, 5 = several times a month, 6 = weekly, 7 = several times a week, 8 = daily. The two most frequently reported offline learning activities were to run through lesson and tech tools before class and to redesign lesson plans to include technology. These activities align to the constructivist theory of learning by doing. The qualitative responses corroborate the importance of hands-on learning. Typical teacher responses were "play around with the tool to see how it works and to see if I can incorporate it in my lessons," "spend time figuring out how to use and incorporate it into my practice" and "have the time to play with it and implement it." These results show that teachers are self-directing their learning by engaging in hands on learning activities that are relevant to their personal context.

Socially constructed knowledge was also a major type of informal learning behavior. The most frequently reported socially constructed offline informal learning experiences were to ask a colleague in my school or district for help and collaborated with a colleague on a lesson to integrate technology. The open-ended responses support these findings. Response examples of socially mediated learning were: "find someone who has used it and to give me an overview," "ask a colleague if they could teach me" and "talk to other teachers about how they're using it." Some teachers indicated the advantages of learning from an expert in their school by responding that

to learn a new technology they would "go to the district tech coordinator for some guidance," "reach out to our technology coordinator for help if needed," and "find an "expert" who could kindly and patiently unpack it for me." In sum, social interaction with tech savvy colleagues is a preferred and common informal learning activity.

A factor analysis of the items also provided the opportunity to explore any trends in the learning behaviors of teachers. The items loaded onto five different learner behaviors: Independent Learner, Local Learner, Traditional Learner, Outward-looking Learner, and Online Social Learner. See Appendix The means and standard deviations of the new learner behavior variables are reported in Table 4.3.

Table 4.3
Means and Standard Deviations for Summed Variables of Interest

			Range	
Variable	n	Mean (SD)	Potential	Actual
Learner Behaviors				
Independent Learner	107	5.22 (1.63)	1 - 8	1 – 8
Local Learner	109	4.25 (1.28)	1 - 8	1.5 - 7.25
Traditional Learner	106	3.33 (1.65)	1 - 8	1 - 7.67
Outward-looking Learner	107	2.77 (1.20)	1 - 8	1 - 5.75
Online Social Learner	108	2.58 (1.79)	1 - 8	1 – 8
Learning Goals				
Classroom Instruction	117	2.70 (.79)	1 - 4	1 – 4
Organization	119	2.31 (.83)	1 - 4	1 – 4
Personal Productivity	117	2.30 (.71)	1 - 4	1 – 4
Connecting	120	2.27 (.78)	1 - 4	1 – 4
Student Centered	119	1.90 (.80)	1 - 4	1 – 4
Depth of TI	88	2.05 (.73)	1 - 3	1 – 3
Formal Learning	94	.22 (.20)	0-1	0 - .78
Years Teaching	129	4.48 (1.29)	1 - 6	1 - 6

Summing the learner activities into learner behaviors allows a more holistic look at informal learning of teachers for technology integration. Again, the data reported is on a frequency scale of 1 = never, 2 = once a year, 3 = several times a year, 4 = once a month, 5 = several times a month, 6 = weekly, 7 = several times a week, 8

= daily. Means of 4.0 or higher indicate that teachers engaged in these activities more than once a month. Independent Learner and the Local Learner were the two most frequently reported learning behaviors and occurred more than once a month on average. The Independent Learner behavior consisted of searching the internet for information, reading books and/or articles online and practicing running through a lesson and tech tools before class. The first activity, searching the Internet, illustrates the ubiquitous mentality to just "Google It" when faced with an information need. The second activity, reading articles online is a by-product of searching for information on the Internet and is a familiar activity that requires relatively low technology skills. These kinds of easily accessible, online learning experiences help empower teachers to be independent learners. In addition, the third activity, practicing before implementation, is a common and universally accepted strategy for anyone learning something new. The fact that teachers are primarily engaging in comfortable and familiar informal learning activities supports Eraut's (2004) finding that a feeling of confidence is important for success in informal learning.

The second most frequent type of learner behavior was the Local Learner. This variable had a mean and SD of 4.25 (1.63) which means that Local Learners engaged in the following four types of informal learning activities at least once a month: asked a colleague in my school or district for help, asked a student for help, collaborated with a colleague on a lesson to integrate technology, and emailed a colleague in my school or district for help. These learning activities involve interactions with colleagues and students that can easily occur within school settings. The Local Learner behavior aligns to Eraut's (2004) findings that informal learning happens as a natural course of the school or work day. Furthermore, the activity of asking a student for help indicates that teachers are accepting a new perspective on their role; they do not always have to be the sage on the stage but can learn from students as well. Clearly, the predominance of informal learning activities that happen locally in

schools amongst teachers and students cannot be overlooked as an important form of professional learning.

Online Informal Learning. Another focus of this study was to explore the potential of Web 2.0 tools and technology resources for informal learning. The findings reported in Table 4.2 under the heading, Informal Online Learning Activities, confirm that teachers are using technology to help them learn albeit in more traditional ways. The three most frequently reported online activities were to search the Internet for information 6.00 (2.00), read books/articles online 4.69 (2.25) and email a colleague in the school or district for help 4.01 (1.62). The first two items, searching the Internet and reading information online, are common activities that facilitate informal learning (Paradise, 2008). The third item, emailing a colleague, is also a more traditional activity because email is a universally accepted, convenient, and familiar mode of communication in the work place. Teachers appear to feel comfortable using established technology tools for their informal learning.

The results reported in Table 4.2 indicate that only a small number of teachers are taking advantage of sophisticated uses of Web 2.0 tools for informal learning. Although reading and posting information on a social media site occurred almost once a month with a mean of 3.94, the high standard of deviation of (2.71) indicates that there is a wide range of activity – people are either doing a lot of it or not. To corroborate the lack of participation in more advanced online informal learning activities, the two least frequently reported activities were to Twitter chat and post a question to a professional listserv. Although posting a question to a listserv in reality is not much more advanced than sending a group email, belonging to and communicating with a community outside of school may require teachers to understand more sophisticated characteristics of digital literacy such as knowing how to communicate and connect on a global scale. Social media tools such as Twitter are less familiar and teachers may perceive them as resources that require more advanced

technology skills and knowledge to use them. These findings indicate that teacher competencies in more advanced aspects of digital literacy need to increase in order for them to feel more comfortable to use them for professional informal learning.

Although the use of more advanced technology tools for informal learning was infrequent, a factor analysis of the items proved that items of this nature clustered together to form an Online Social Learner behavior (see Table 4.3). The Online Social Learner behavior consisted of: Twitter chat, followed an educational blog or newsfeed, and connected with a group online with similar interests. These teachers are using technology to seek new ways of collaborating and communicating with others beyond the school walls. Although the quantitative findings indicate that Online Social Learners were the least frequent type of learner behavior with a mean of 2.58 (1.79), they are the innovators exploring new modes of informal learning. As Spires, Wiebe, Young, Hollenbrands, & Lee state, teachers should "take on the challenge of acquiring the new global skill set themselves" (2012, p. 249) for professional learning. The more enthused teachers become using Web 2.0 technologies, the more these online activities and behaviors may become a regular part of self-directed lifelong learning.

A look at the qualitative data provided more details into the range of tools and online resources that help teachers with educational technology integration. The majority of the responses indicated simple uses of technology to learn such as "YouTube…for quick instruction on making task easier or quicker," "Diigo Education mailing list for daily tips from colleagues around the world," "Teaching Channel for videos of teachers actually teaching," and "Free Tech for Teachers Newsletter." Response data also provided insight into teachers' use of content specific online resources. For example, a social studies teacher liked NCSS SmartBriefs, an education news site sponsored by their national professional social studies organization to learn technology integration for his content area. An English teacher followed the blog of a well-known tech savvy English teacher. Lastly, a teacher used

Twitter in order to "connect to other teachers of the same content… they post great ideas." These responses help describe the different ways that teachers are using technology tools to help them with educational technology integration.

In sum, informal learning is an effective way to learn because learners choose their delivery method and set their own learning goals that are meaningful within their lives and contexts (Schugerensky, 2000). The qualitative findings are evidence that online resources are allowing teachers control over how and what they learn, enabling them to personalize their learning to be relevant to their content area and needs.

Research Question 1a – What is the Relationship Between Formal and Informal SDL Experiences?

Finding #2. *High school teachers in ES1:1 device schools who are online social learners are more likely to participate in formal learning activities.*

Teachers were asked if they had participated in different types of formal learning. This question was scored with 0 = no and 1 = yes for nine different kinds of formal learning experiences (see items under Formal Learning in Table 4.2). School or district non-required professional development (PD) and local professional organization workshops were the two most frequently reported formal learning activities that teachers participated in on their own accord. About half of the teachers on average engaged in either of these two formal learning activities during the last twelve months. When the items were summed into one variable, Formal Learning, it was apparent that overall, teachers did not participate frequently in formal learning activities (see Table 4.4). The findings show that on average only one in five teachers chose to participate in any type of formal learning activity on their own accord in the past twelve months.

The summed variable, Formal Learning, was used to explore any relationships between formal and informal learning. A regression analysis using the enter method was calculated to see if any of the learning behaviors of Outward-looking,

Independent, Local, Online Social, or Traditional predicted engagement in Formal Learning. A significant regression equation was calculated based on the learning behavior Online Social that predicted engagement in Formal Learning.

This means that teachers who were Online Social learners were more likely to engage in formal learning activities. Online social learning and formal learning seem like opposite ends of learning activities with online social being the most learner centered, on-demand, unstructured tech savvy method, while formal learning is the most traditional and structured. One explanation is that it might speak to the common traits of self-directed learners: curiosity to learn and motivation (Candy, 1991). Those teachers who are curious and motivated to explore new ways of online learning may likely be the one who are curious and motivated to further their education through as many avenues as possible, including traditional methods.

Table 4.4

Learning Behaviors as Predictors of Participation in Formal Learning Activities

Variable	B	*B*	95% CI
Constant	-.100		[-.240, .040]
Online Social	.032*	.269*	[.003, .061]
Outward-looking	.017	.101	[-.027, .061]
Independent	.017	.148	[-.011, .045]
Local	.009	.060	[-.025, .044]
Traditional	.023	.188	[-.005, .050]
R^2	.360		
F	8.569		

Note. $N = 82$. CI = confidence interval.

* $p < .05$.

Research Question 2 – How Do Teacher Characteristics and Personal Learning Goals Relate to Engagement in SDL Activities for Technology Integration?

Linear regressions were conducted to see if years of experience, gender, or any of the learning goals of Classroom Instruction, Connecting, Organization, Personal Productivity and Student-centered predicted any of the five informal Learning

Behaviors (Outward-looking, Independent, Local, Online Social, and Traditional). These variables were highly inter-correlated which means teachers are doing a lot of every variable (see Table 4.5).

When regression analyses on the variables were run, however, two statistically significant findings were calculated.

Finding #3. *High school teachers in ES1:1 device schools who have identified Connecting as a learning goal are more likely to be Online Social Learners.*

A linear regression using the enter method was conducted to see if any of the learning goals of Classroom Instruction, Connecting, Organization, Personal Productivity and Student Centered predicted Online Social Learning. A significant regression equation was calculated based on the learning goal of Connecting that predicted Online Social Learner Behavior. Although the learning goal of Connecting significantly predicted Online Social Learning behavior; Classroom Instruction, Organization, Personal Productivity and Student-centered learning goals did not (see Table 4.6).

This finding means that teachers who identified Connecting as a learning goal were more likely to be Online Social Learners. The learning goal of Connecting consisted of three items: collaboration tools such as Google docs or Padlet, communication tools between students and teachers such as Twitter or blogs, and video chat tools such as Skype, Goggle Hangout, or iChat. The fact that the teacher learning goal of Connecting predicts Online Social Learner behavior is testimony to teacher understanding and competencies in their own digital literacy skills. Teachers