2013-04-22

Unfamiliar Technology and the Architect of Learning

Stuewe, Nancy

UNIVERSITY OF CALGARY

Unfamiliar Technology and the Architect of Learning: A Case Study

by

Nancy Stuewe

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE

DEGREE OF DOCTOR OF EDUCATION

GRADUATE DIVISION OF EDUCATION

CALGARY, ALBERTA

APRIL, 2013

Abstract

Technology is an element of human life worthy of reflection, from the apparent proliferation of technological use in society to the rapid changes in the way we connect and relate to each other through technology. Contemporary ways of thinking about knowledge and work suggest that teachers have been challenged to entertain new and emerging technology in their classrooms. The primary intent of this descriptive case study was to develop an experiential understanding of how teachers might make sense of new and emerging (unfamiliar) technology as a process.

The study explored two main questions: 1) How do teachers make sense of new and emerging technology to enhance teaching and learning? 2) How might these teachers' insights inform strategies to support the implementation of a new technology in teaching and learning? A framework of enablers was constructed to make sense of the complexity of teacher experience with unfamiliar technology to support the process of meaningful learning.

Key findings provide practical knowledge and suggestions to support teachers with the implementation of unfamiliar technology in teaching and learning. Teachers must be willing to learn with technology and their capacity to grapple with or even entertain the unfamiliar will benefit from a collection of external affordances. If society wants teachers to grapple with new and emerging technology, teachers need some sort of supportive system with opportunities to better understand and address technological constraints. The lesson learned is that one size will not fit all when looking to bolster teacher capacity. Teachers will benefit from participating in building personal pathways for sense making of new and emerging technology.

Acknowledgements

Just once in a lifetime
There's one special moment
One wonderful moment
When fate takes your hand
And this is the moment
My once in a lifetime
When I can explore a new and exciting land

For once in my lifetime
I feel like a giant
I soar like an eagle
As though I had wings
For this is my moment
My destiny calls me
And though it may be just once in my lifetime
I'm gonna do great things.
(Garland, 1964)

As journeys go the doctoral experience has been an experience with many unplanned twists and turns in the road. As with the research, my capacity to complete this work has been met with many enabling and constraining events. I would not have been able to become aware of any of my own abilities without my beloved husband and my beautiful children. I also give many thanks to Bryce Willis for introducing me to the happiness advantage that fuelled this success.

Looking at the world with a happiness advantage allowed me to recognize many things to be thankful for. I am thankful for the beauty in the world. I am thankful that I am creative and never content with doing things the conventional way if a more interesting way might be possible. I am thankful for my curious nature left to me from my father and for my mother's courage. I am thankful for great mentors from the Faculty of Education at the University of Calgary: Dr. Michele Jacobsen, Dr. Hanan Yaniv, Dr. Gail Kopp, Dr. Jim Paul, Dr. Pat Tarr and Dr. Susan Crichton for encouraging me to approach my study with a life-long kindergarten spirit.

I also am thankful for the story of experience that John Dewey left me to reinterpret into my own experience a hundred years after he told it.

I need to pay particular attention to Dr. Jennifer Lock for re-awakening my drive to complete this grand endeavour. Thank you Jennifer for my researcher hat and for listening when I needed a shoulder to cry on and for reminding me what was important. Thank you for keeping me on track when absolutely every thing seemed interesting. Thank you for reading and re-reading every section and every chapter over and over again. Thank you for never losing your patience with me when you reminded me yet again of past tense and especially for never losing faith in me.

In closing I wish to thank the many teachers I have known who every day dance around constraints as they endeavour to provide for their students a responsive learning environment, where the learning drives the use of technology. In particular, I thank the teachers in my study who opened their classrooms to let me learn.

Table of Contents

List of Figures and Illustrations

Chapter One: Introduction

In this chapter I begin with an overview of the background and context that framed the study and continue with the statement of purpose and the research questions. Also included in this chapter is a discussion of the rationale and the significance of the study. The chapter concludes with a discussion of what I as the researcher brought to the study, the theoretical framework, and an overview of the organization of this dissertation.

Background and Context

The *architect of learning* is a metaphor that I used to describe the role and context of teachers in a constructivist approach to learning. An architect designs the plans from which others will build (Shepherd, 2011). An architect designs a plan that is personalized to each job. They participate in the building by overseeing the construction. They have a knowledge of the tools to be used in each project. An architect ensures that the people on site are communicating and working well together. They are mindful of the interior of a project in the same way as a teacher might focus on personalized learning and critical thinking opportunities for each student. An architect can expand a view just as a teacher might expand horizons and allow students to make connections to prior experience and creativity. An architect assesses the structure and revisits the plans to make adjustments when necessary and a teacher utilizes various assessment methods to engage students in meaningful learning. I believe this metaphor of teachers as architects of learning captures the complexity of educators' work.

It has been suggested that the role of teachers be reworked "from knowledge authority to an *architect of learning* - one who plans, designs and oversees learning activities" (Government

of Alberta, 2010a, p. 7) while at the same time there is a call for teachers to use technology differently to support this constructivist approach (Glassett & Schrum, 2009; Howland, Jonassen, & Marra, 2012). Educational technology research has identified many barriers for teachers to integrate new and emerging technology in their teaching and learning environments (Allen, 2008; Ertmer, 2005; Glassett & Schrum, 2009; Olsen, Recker, Robertshaw, Sellers, & Walker, 2011; Schoepp, 2004). Further, it is important to note the existence of interconnections of many layers of traditions in education and many perspectives of knowledge in classrooms. How teachers might approach unfamiliar technology depends greatly on their beliefs about how people learn and on the demands of their job (Molenda, Rezabek, & Robinson, 2008).

The *architect* teachers use "new technologies as designers and creators of knowledge" (Government of Alberta, 2010a, p. 29). While UNESCO (2008) reported that our relationship with digital technology is dramatically transforming the way we live in the world, globalization, the rise of the knowledge economy, and rapid technological changes have also increased the likelihood that both new and experienced teachers will regularly come in contact with new and emerging [unfamiliar] technology (Willis, 2001).

The point of the research was to understand teacher experience at the intersect of these conditions, believing that when teachers engage with unfamiliar technology, the greater educational community will benefit from understanding their experience. The study was concerned with teacher experience with new and emerging or unfamiliar technology as a process. The present research was situated along side but separate from another study called the iPad Project. The purpose of the iPad Project was to gain an understanding of the infrastructure required to support handheld devices in K-12 classrooms. The iPad Project was conducted in two phases over a period of two years. Phase One which lasted one year resulted in the article, "Is

Your School Ready For Mobile Learning?" (White, Crichton, & Pegler, 2010). Phase Two resulted in "Personal Devices in Public Settings: Lessons Learned From an iPod Touch/ iPad Project" (Crichton, Pegler, & White, 2012). The research underpinning the iPad Project illustrated the need for teachers to adopt a constructivist framework and become *architects of learning*. Three teachers from the iPad Project volunteered to be part of my study. Together they chose to teach with Apple's iPad and had no prior experience with its use in or out of the classroom. My study had a different purpose.

Purpose Of The Study

The purpose of this descriptive case study was to explore the issue of how teachers might make sense of their experiences in using new and emerging technology, or unfamiliar technology such as Apple's iPad. The study had several synergetic goals: a) to develop an experiential understanding of the issue as a process by describing teacher experience and exploring the context of their experience; b) to explore possible motivations, tensions, and affordances to entertain unfamiliar technology; c) to interpret these events as lessons learned in order to develop ideas for support and further study. This type of understanding required a research role of participant observer to collect and analyze data within the school setting. The following questions guided the research:

1. How do teachers make sense of new and emerging technology to enhance teaching and learning?
2. How might these teachers' insights inform strategies to support the implementation of a new technology in teaching and learning?

Rationale For The Study

My study is grounded on two key factors. First, in my review of the literature I found an extensive list of factors that potentially affect why teachers may not use new and emerging technology; these factors were usually reported in the form of barriers (Allen, 2008; Becker, 2000; Cuban, 2001; Levin & Wadmany, 2008; Schoepp, 2004; Schrum, Shelly, & Miller, 2008; Zhao & Frank, 2003). However, I found that a rather limited number of studies had examined the context and the process of sense-making of new and emerging technology from a teachers' perspective. According to Schrum et. al. (2008) concerns about the slow adoption of technology in the classroom are not new. Previous research such as that by Zhao and Frank (2003) identified how the focus on barriers seems removed from the system or context in which teachers interact with technology. Zhao and Frank stated that limited research has been undertaken to investigate the dynamic nature of technology adoption by teachers within the complex context of the teaching and learning environment. This understanding has highlighted a need to develop experiential knowledge and study teacher experience in adopting new and emerging technology as a process within their classroom.

The second reason for my study was also to expand on current educational technology research and identify ways to support the implementation of new and emerging technology. Not only will the greater educational community benefit from another study, but readers may also develop practical knowledge about the complexity of teacher experience with unfamiliar technology through vicarious experience (Stake, 1995). Schrum et al. (2008) have described the characteristics of "tech-savvy" teachers as willing to overcome constraints, being risk-takers and curious, as well as having a strong desire for life-long learning. Ketelaar, Beijaard, Boshuizen and Den Brok (2012) have highlighted that sense-making for teachers engaging with new and

emerging technology is embedded in their situation and can be cultivated in a supportive environment.

My study has added to the general foundation of understanding upon which the greater educational community can make professional decisions in three ways. First, the study provided an enhanced understanding of the potential of the capacity of teachers and their constructivist teaching and learning environments. Second, a process view of educational technology offered insight into the interconnected responsibilities to support teachers, rather than a conventional way of looking at how a new technology as a means to an end might afford education. Third, the study had social significance; when any teacher engages with unfamiliar technology to support meaningful learning, the greater educational community will benefit from better understanding their experience. The study provided rich descriptive information about a framework of enablers for teachers to entertain unfamiliar technology.

What The Researcher Brings To The Study

I have been a teacher in technology-enhanced teaching and learning environments for many years. I have direct experience teaching and supporting other teachers who are learning to support meaningful learning with technology. The study was undertaken because of a personal intrinsic need to better understand how to support teachers to make sense of new technology and make its integration into the process of teaching and learning painless. As a researcher it then became important to highlight teacher experience and voice. The study was conducted within a constructivist framework. This framework was borne out of the qualitative research tradition and placed me as the researcher within the process and situation of study. Denzin and Lincoln (2008) described qualitative research as a set of interpretive practices that "make the world visible. These practices transform the world. They turn the world into a series of representations,

including field notes, interviews, conversations, photographs, recordings and memos to the self" (p. 4). The act of writing this dissertation was intended not just to be the end product of the study, but also to be a method of constructing an understanding of what happened (Creswell, 1998). An interpretive bricoleur method was required to weave the data into rich description. Denzin and Lincoln (2008) described this method as a piecing together of a set of representations. Writing the dissertation was a pragmatic, strategic, self-reflective and interactive experience of inquiry.

Theoretical Framework

Constructivism

The constructivist framework for meaningful learning with technology promotes technology as a pathway for understanding. Duffy and Cunningham (1996) have noted that constructivism is an umbrella term for a wide range of ideas. The common elements for education are learning as an active process of construction rather than of acquiring knowledge, and instruction as a process that supports construction, not simply transmission, of knowledge (p. 2). Knowledge is built on a capacity for knowledge construction. The common ground of constructivism invites us to contemplate a world full of meaning to make sense of our experience. It is perhaps best summed up by von Glasersfeld's (1989) statement that "instead of presupposing knowledge is a representation of what exists, knowledge is a mapping, in the light of human experience, of what is feasible" (p. 134).

Constructivism can also be characterized as a negotiated understanding, that we know what we know with and from each other and the world. Constructivism is built on a sense of individual and social responsibility (Jonassen, Hernadez-Serrano, & Choi, 2000). This suggests that each individual way of making sense of the world is valid but reality is socially constructed

(Crotty, 1998; Merriam, 2009). In this framework Duffy and Cunningham (1996) stated, "we do not assume that we must have a common meaning, but rather we actively seek to understand the different perspectives" (p. 2). For example, in the classroom a teacher might highlight to her class how an individual student's experience is unique, yet through classroom conversation other students might see connections to their own similar experiences. Through dialogue, students can determine how closely their experiences are shared. Teachers can then challenge student thinking to become sensitive to diverse thought. The teaching and learning process might begin when the teacher creates conditions where questions are addressed. This does not mean that the teacher will hide the answers in the activity where the student can find them like a game of hide and seek. Instead, teachers create activities where there really is more than one right answer. "Knowledge is not a matter of getting it right but rather acquiring habits of action for coping with reality" (Rorty as cited in Duffy & Cunningham, 1996, p. 1). Perhaps the students will uncover a solution that the teacher has not yet thought of. Understanding then is an outcome of the learning process and the teacher is part of the process. Learning is achieved through negotiation within and among the community of learners. The learner questions, seeks different perspectives, judges viability, and comes to a shared understanding from what makes sense. Meaningful learning with technology supports learning through conversing and collaborating with others (Howland et al., 2012).

Duffy and Cunningham (1996) stated that the teacher's role is to become a guide to support "students as they struggle with constructing their connections to and with a socio-cultural context" (p. 26). Within a constructivist framework what drives learning is a seeking for understanding and sustained engagement in activity (Crotty, 1998; Howland, Jonassen, & Marra, 2012). Teachers strive to design problems and tasks that both enable and constrain, thus leading

to transformation through participation. Zhang and Patel (2006) went further to say that instruction becomes a tool to support the act of construction rather than communicating knowledge. Instruction needs to support a learning-by-doing process not to deliver someone else's thinking.

Howland et al. (2012) redirect the attention of meaningful learning away from the hype of technology. They have stated, "learning is a natural, adaptive human process" (p. 3). If schools are to foster meaningful learning, Howland et al. argue that teachers must treat technology as a partner in the learning process. In this light, technology is more than a device. "Technology consists also of the designs and environments that engage learners" (p. 7). As a pathway for understanding, digital media might spark student creativity and action. Technology then has the potential to engage, facilitate, and form a non-linear place to support the teaching and learning process. Technology then might broaden our human capacity to learn. Technology as an intellectual partner supports the individual in reflecting and processing the dissonance between what they perceive and what they think they know as a meaning-making event. Resolution ensures some ownership of the knowledge constructed.

Constructivism also has a focus on the whole teaching and learning environment where individuals are to be open to multiple perspectives and interpretation (Jonassen, 1992, p. 137). Jonassen et al. (2000) stated that meaningful learning follows a process that is experiential and reflective. Duffy and Cunningham (1996) have related that in a sociocultural approach to constructivism, learning occurs as people participate in shared endeavours and collective action. In a constructivist approach teachers participate in the learning in their classrooms, they do not just interpret the world and have their students repeat back what they have been told.

Following von Glasersfeld's (1989) idea that knowledge is a mapping in the light of human experience, making sense of the complexity of teacher experience came through a constructivist epistemology. Constructivism suggests that meaning does not live in an object waiting for researchers to discover it. In a constructivist framework, researchers construct meanings as they engage with the world. According to Creswell (2009) constructivist researchers, "recognize that their own backgrounds shape their interpretation, and they position themselves in the research to acknowledge their interpretation" (p. 9). Characterized by Denzin and Lincoln (2008) as bricoleurs, researchers need to be self-reflective, multiple skilled, and resourceful. Research in the constructivist vein invited me, as a researcher, to pay sustained attention and to dialogue with the data gathered in the study "in a radical spirit of openness to its potential for new or richer meaning" (Crotty, 1998, p. 51).

The focus of a case study is a *case* (Stake, 1995). As a case study my research became a reflective method of gathering and analyzing data related to my research questions. Stake related that most contemporary qualitative researchers nourish the constructivist belief that knowledge is constructed rather than discovered (p. 99). As a methodology, it became the strategy to understand and explain my participant-observer experience. As a sense-making process the focus was on organizing, reflecting, and reporting the results as description as well as constructing and applying meaning to what was observed as interpretation. The process was more than simply a method of collecting data. Constructivism became the theoretical perspective informing the methodology. As Stake suggested, case study research shares with constructivism the burden of clarifying description and sophisticating interpretations. With an emphasis on *rich description,* Stake related that good narrative material provides for readers opportunities for a personalized generalization (p. 102). Therefore the advantage with case study is this holistic approach to

studying the issue of teachers making sense of unfamiliar technology in their natural teaching and learning setting, that of the classroom.

Overview of Dissertation

The study of teacher experience with unfamiliar technology has been organized into six chapters.

- Chapter One – Introduction to the study
- Chapter Two – Review of literature
- Chapter Three – Research methodology
- Chapter Four – Research findings
- Chapter Five – Discussion of findings
- Chapter Six – Discussion, recommendations, and conclusion

Chapter Two: Literature Review

The purpose of the study was to explore how teachers made sense of unfamiliar technology within their teaching and learning situation as well as to explore ways to support the implementation of new and emerging technology in classrooms. According to Sawyer (2006) studies of knowledge workers show that teachers apply their expertise in complex settings with a wide array of teaching tools from emerging technology to pencil and paper. Schrum et al. (2008) reported that enormous funds have been devoted toward encouraging teachers to adopt new and emerging technology, yet not much has changed in spite of this expense and effort. To understand the complex perspectives in how technology is utilized and adopted in teaching and learning environments, I begin this literature review with a broad definition of technology followed by a brief exploration of four different traditions of education and a definition of new and emerging technology (tablet computing). This exploration focuses on the relationship between the role of the teacher, the beliefs in a teaching and learning environment, and how technology might be employed to support these beliefs. In this review, I also explore four sources of change in the role of teachers, the invitation for this change, and a framework of enablers for teachers to use emerging or unfamiliar technology.

Defining Technology in Education

Amiel and Reeves (2008) noted a need for educators to become more philosophical about their view of technology and the value it holds to support learning. Ihde (2004) related that a conservative interpretation of technology is "simply as a human invention[s] which get used in good or bad ways" (p. 99). Ihde pointed out that a tool perspective of technology can take on a value-neutral or a value-laden role. Cuban (2001) suggested that policymakers as well as

teachers expressed a value-neutral view of technology in his study. However his observations suggested something different. Cuban (2001) stated that "wiring schools, purchasing computers, networking machines, and using the machines themselves are hardly value-free behaviours" (p. 164). The using and choosing of technology for a purpose is a specific value choice in itself (Cunningham & Allen, 2010). Ihde (1993) described this dualistic view as utopia versus dystopia. A double-edged sword metaphor can be used for this view. However technology is not just objects we handle and as Ihde remarked, dualism, "makes for great difficulty in a careful, balanced, and critical analysis" (p. 62).

A double-edged sword metaphor of technology limits our understanding to good or bad in how it functions or as skill we can master. Alternately, a ground-map metaphor may permit us to be open to more complexity and to pay particular attention to the process as well as the many activities, regions, resources, and boundaries of technology use (Cunningham & Allen, 2010). Ihde (2004) stated that John Dewey was concerned with "developing a primacy of praxis orientation to philosophy" (p. 96). Hickman (2002) in reviving Dewey's pragmatism described technology as a complex process that includes not only the device but also the thoughtful use of it with a goal to resolve issues. Amiel and Reeves (2008) have also stated, "technology is much more than hardware. It is a process that involves the complex interactions of human, social, and cultural factors as well as the technical aspects" (p. 31). This birds-eye perspective of technology allows us to expand the boundaries around its use and to see technology as a tool to engage in work and at the same time a skill that we can learn to master. However, skill involves experience; to do better requires know-how which includes a process of teaching and learning. "Technology is not a product and instead is a process: tools are merely a product of a technological system" (Amiel & Reeves, 2008, p. 32). As a process, technology is not just a

means to an end, but ends and means all bound up interactively in practice (Hickman, 1992). It may also be seen as a means through which we might relate, communicate, and participate with the world.

Neither technology nor education is value free. Branch and Deissler (2008) have described education also as a process, a series of purposeful actions and operations. They have suggest the process of education can be supported with the use of technology. To expand the boundaries of technology's definition further, Internet-based learning management tools, such as Desire2Learn™ (D2L), allow teachers to consider technology also as an environment, as a place we can design, work, and interact within. Feenberg (2002) suggested that a new metaphor for technology might be a house, not just a device but an "extremely rich and meaningful life environment" (p. xi). Within this complex view, people and not the device have volition. Teachers have the opportunity to use technology with knowledge, action, and make connections to ideas and others. New information and communication technologies allow classrooms to connect with individual access and also with participatory knowledge-building capabilities (Cunningham & Allen, 2010). Wikis, blogs, Google Docs, and collaborative mind-mapping tools allow users to critique and potentially build on each others ideas.

In these technology-enhanced learning environments, Amiel and Reeves (2008) expressed concern that these new information and communication technologies greatly increase the complexity of the integration of technology into educational environments. Derry (2008) cautioned, "even though recent work has concentrated on more detailed questions of learning and pedagogy, the question of knowledge has been neglected" (p. 509). Derry suggested that what has been downplayed is the human dimension of the nature of knowledge while at the same time the glamour and hype of technology have been highlighted.

Traditions in Education

According to Sawyer (2006) much of society is unaware of important discoveries emerging from the learning sciences regarding how people learn and how technology can assist in the process in education. Sawyer has suggested that most parents and policy makers remember a focus on instruction and memorization of facts. Teachers also have either spent a career learning the skills to manage an instructionist classroom or have strong memories of being students in such classrooms. In a current time of transition, many interconnected perspectives of knowledge exist in education. Teachers in general find themselves in the midst of many philosophical and ideological traditions (Barrow, 2010; Sawyer, 2006, 2008). Molenda (2008) noted that how and if a technology is considered at all will depend on the beliefs of teachers in a teaching and learning environment. The following is a brief exploration of the relationship between the role of teachers, their beliefs in a teaching and learning environment, and how technology is employed to support these beliefs in four different traditions in education; instructionist, humanist, reconstructionist, and constructivist.

Instructionist.

In an instructionist tradition of education, knowledge is gained and measured in steps. Cunningham and Allen (2010) described unified standards by age, content, and performance. Accountability systems are structured by a hierarchical approach for improving achievement in teaching and learning (p. 486). The role of the teacher is that of a *knowledge authority* to prioritize the standards and find a way to measure progress. The decisions teachers make are data driven. The teacher looks for objective evidence of what is working or not in order to make appropriate adjustments (McNeil, 2009). Educational research is utilized to assist teachers in achieving the curriculum objectives not in participating in its creation (Sawyer, 2006).

According to Duffy and Cunningham (1996) technology is adopted by instructionist teachers as a teaching or delivery tool to "provide more effective and efficient delivery of instruction and hence more effective and efficient learning" (p. 18). McNeil (2009) also noted that technology is regarded as an instructional intervention in this systemic curriculum. Technology becomes an efficient way to achieve knowledge acquisition and proof of conceptual understanding (p. 161). The tool of choice for the teacher with these objectives might be one that will help students add to their knowledge store, such as word processing, CD-ROMs, PowerPoint, and drill and practice websites.

Humanist.

According to McNeil (2009), a humanistic teaching and learning tradition, in contrast to instructionist, is concerned with self-understanding and fosters emotional and physical growth. The goal is to foster intellectual skills necessary for independent judgement. Its purpose is to provide the learner with intrinsic rewarding experiences that contribute to personal liberation. The role of the teacher is to provide a warm and trusting environment as well as to function as a facilitator while providing challenging learning opportunities. In a humanist tradition, the learning focus is on knowledge gained through personal concerns and self-expression. Underhill (1989) described humanist education as a process of life-long learning. The job of a teacher-facilitator is not to decide what the students should learn but rather to identify and create the ingredients of a climate that helps free them to learn and grow. Reflective discussion is a key ingredient for negotiation and choice in matters of authority and responsibility in the classroom. Autonomous and authoritative power is in continuous flux. Classroom decision-making continuously shifts back and forth.

McNeil (2009) highlighted the idea that technology opens many possibilities of exploration in humanist education for teachers and students. However, its use focuses on learning and meeting the needs of people. In the humanist tradition, technology assists in finding the answers to personal questions, connecting people to each other, and helping people to make decisions.

Reconstructionist.

McNeil (2009) explained that a *reconstructionist* teaching and learning tradition differs from the humanist in its focus on confronting the students with real world concerns. There are no universal objectives, in that these come from the situation of concern. The role of the teacher is to relate world issues to the students' personal goals, to stress cooperation, and to allow for cross-curricular integration. In a reconstructionist tradition, technology is accessed to raise social consciousness and as a "tool for global and multicultural social activism in the interest of human betterment" (McNeil, 2009, pp. 159–160).

Constructivist.

In a constructivist perspective, learning is a complex process that is primarily under the control of learners. It occurs under the teacher's guidance within the context of the teaching and learning environment (Duffy & Cunningham, 1996; Molenda et al., 2008). The focus is on a process for learners to make connections in a whole world of meaning. The role of the teacher is like an *architect of learning*, "one who plans, designs and oversees learning activities (Government of Alberta, 2010a, p. 7). Teachers "strive to create environments where learners actively participate in the environment in ways that are intended to help them construct their own knowledge" (Jonassen, 1994, para. 13). Duffy and Cunningham (1996) stated that "learning is seen to occur when the learner's expectations are not met, and he or she must resolve the

discrepancy between what was expected and what was actually encountered" (p. 6). Constructivists stress the importance of self-awareness of learning and knowing. Duffy and Cunningham preferred the term reflexivity. It is a process of construction in which conflict of understanding leads to puzzlement and questions. These questions, McKenzie (2000) related, help us to make sense of the world. McKenzie also explained that in the constructivist tradition, questions might be our "most powerful tools when it comes to making decisions and solving problems, for inventing, changing and improving our lives" (p. 1).

Howland, Jonassen, and Marra (2012) have used the term *meaningful learning* to describe a process of learning through inquiry. With its interrelated, interactive, and interdependent characteristics, meaningful learning, they say, is active, constructive, intentional, authentic, and collaborative. In this way Howland et al. have related that technology becomes a "partner in the learning process" (p. 7). Meaningful learning happens *with* technology, not because of technology. They suggest technology can be thought of as an intellectual partner in the learning process. Derry (2008) also believes that the principle of design of technology-enhanced learning environments should have a learning-driven focus and not a technocentric one. Learning should drive the use of technology, not the other way around. In a constructivist tradition, technology can be viewed as a pathway for learning, not a delivery vehicle. Teachers do not need to become experts with technology to support learners and learning; they only need a working knowledge and a willingness to try.

Technology becomes a complex notion of devices, process, and practice that also includes methods of fruitful questioning. The implications of learning with technology in a constructivist perspective is that teaching and learning becomes linked in a process. Instruction may spark curiosity and questions can motivate intelligent action that in turn may lead to an

accumulation of experience. Together instruction, questions, and technology could mediate the teaching and learning process. Jonassen, Carr and Yueh (1998) have used the term "mind tools" to describe the process in which learning with technology becomes an "intellectual partnership" (p. 31).

Educational Technology

The Association for Educational Communications and Technology (AECT) connects technology with education in their definition of educational technology as "the study and ethical practice of facilitating learning and improving performance by creating, using and managing appropriate technological processes and resources" (Januszewski & Molenda, 2008, p. 1). The definition can take on different meanings in these different traditions.

The instructionist tradition of education suggests knowledge is scarce and reality is objective; technology then may be accessed as a neutral tool to support the efficient collection of data and improve delivery of instruction (McNeil, 2009). In a *knowledge authority* role, *facilitating* becomes an action by which teachers can control outcomes and stagger students' steps in order to make the process through stages successful. With words like *improving* and *performance,* teachers might want to collect quantifiable data to measure a before and after test score and look for objective truth found in observable evidence (Crotty, 1998).

However with an *architect of learning* (constructivist) perspective of education, the AECT definition takes on different values. The word *facilitating* may be interpreted as a creative process of constructing a learning environment that is suitable for exploration. Understanding the value of technology becomes a process or a networked activity (Amiel & Reeves, 2008). Teachers look for more pragmatic evidence of projects completed (Howland et al., 2012). Truth is socially negotiated (Crotty, 1998). An *architect of knowledge* might use technology as a

process to connect to ideas and to construct and communicate understandings. With a process view, technology not only lends itself to the exploration of questions but potentially could be used to take learners *on* an exploration and perhaps could be thought of a *place*. Schrum (2005) pointed out that well before technology can be used effectively in this way, "exploration must be valued as important to both teaching and learning" (para. 9).

Review of technology in education.

It is important to note that many layers of traditions and many perspectives of knowledge are interconnected. Teachers will use technology to serve their needs in the time and place in which they work. How teachers think of technology and how they create, use, and manage learning resources depends greatly on their beliefs about how people learn as well as the demands of their job (Molenda et al., 2008, p. 19). As architects of learning (a constructivist tradition), teachers understand that what makes learning meaningful is a personal exploration of content, a focus on designing good tasks for exploration, and a willingness to gain enough awareness of technology to support the process as an intellectual partner. Januszewski and Molenda (2008) sum up the need to connect technology, teaching, and learning with the real world with the question, "If learners do not use the knowledge, skills, and attitudes outside the classroom, what is the point of teaching them?" (p. 5).

What has emerged from the literature thus far is a complex depiction of technology as a process that includes the tool or device that could be mastered with skill and experience. Educational technology has also been presented as a process. In addition, with a process view, technology may be viewed as a place in which we might relate, communicate, and participate with the world. This view of technology highlights a need to encourage teachers to develop an awareness of a relationship between learning and technology. Howland et al. (2012) stress that

meaningful learning occurs with technology, not from it. The focus then becomes more on how technology supports the human process of teaching and learning and less on a means to an end and flashy technocentric thinking.

Knowledge, Technology, and Educational Change

New findings from the learning sciences about the nature of knowledge have significantly changed how we understand learning (Sawyer, 2006). At the same time globalization, the rise of the knowledge economy, and rapid technological changes have impacted skill requirements in the labour market (Varghese, 2011). McCrory (2006) situated this new knowledge at an intersection of pedagogy and technology. In an effort to take a holistic examination of educational change, in this literature review I have highlighted the following three elements that influence teachers' experiences with technology; a) a new understanding of the nature of knowledge; b) the rise of the knowledge economy; and c) rapid technological expansion.

A new kind of knowledge.

Sawyer (2006) related that conventional schools view knowledge as a collection of facts and the learning goal is to get these facts into the students' heads. The teacher's role then is to deliver the facts. According to Sawyer, the learning sciences focus on knowledge differently, and aim at a deeper conceptual understanding as a valued outcome of learning. The teacher, Sawyer related, participates in the learning process as they focus on creating learning environments with real-world problems. Teachers focus on building on learners' prior knowledge as they create opportunities for reflection. Educators have discovered a "mismatch between the schools we have today and the demands of the knowledge age" (p. xii). Many researchers recognise teachers as change agents for a new kind of knowledge and see fostering change in teaching as a central concern of the learning sciences (Fishman & Davis, 2006; Hargreaves, 2003). With this new

kind of knowledge, there is pressure on teachers to accept and implement a new model of learning (Howland et al., 2012). This new model of learning shifts the focus away from acquiring surface knowledge to developing a sustaining deep learning that is situated in everyday activities and real world experience (Sawyer, 2006). Derry (2008) adds that what is different is a purposeful participation by both teachers and learners regardless of the setting.

The knowledge economy.

Sawyer (2006) has noted that leading thinkers in all facets of society believe education must change for a new knowledge economy. UNESCO (2005) has connected the knowledge economy to business and the knowledge society to the public. The main shift in thinking is that knowledge is not only a support for work but has become a form of work. Organizations like UNESCO see the demands of the knowledge society as positive but caution that "to remain human and livable, knowledge societies will have to be societies of shared knowledge" (p. 5). Teachers increasingly need to prepare students to participate as workers in both the knowledge economy and knowledge society. Hargreaves (2003) added that knowledge societies need schools that are sites for knowledge construction, that cultivate deep cognitive learning, creativity, and ingenuity among students while pursuing continuous professional learning for teachers. This has placed more pressure on teachers to participate in the learning in their classrooms.

Technological revolution.

Connected to these influences of change is how the adoption of digital technology in society is dramatically transforming the way we live in the world. "The digital revolution, fired by the engines of Information and Communication Technologies, has fundamentally changed the way people think, behave, communicate, work and earn their livelihood" (UNESCO, 2008). In

Alberta, “the Teaching Quality Standard, places an expectation on teachers to apply a variety of technologies to meet the mandated learning outcomes across the curriculum” (Alberta Education, 2012, p. 3). In an exploration of assumptions for technology and teacher education, Willis (2001) stated, “new and experienced teachers will regularly come in contact with new technology they have no experience with” (p. 305).

New technologies such as Webquests or scenario game based learning quests have also played a significant role in supporting a problem-solving model for learning instead of offering ready-made solutions for students to tackle. A problem-solving model “confronts students with didactic situations in which there is an obstacle to be overcome” (UNESCO, 2005, p. 82). The unintended consequence of the pervasive nature of technology and the rapid pace of technological change is that it potentially generates an uncomfortable feeling for teachers needing to keep up with new and emerging technology. This has placed more pressure on teachers to be willing to take risks with new and emerging technology and to learn with their increasingly tech-savvy students (Schrum et al., 2008).

Education.

This new understanding of knowledge, the economy as well as the eager adoption of technology by society are interconnected with what we need an education system to do. A fundamental assumption of the learning sciences is that learning is not a thing, but a process (Barab & Squire, 2004). Gardner (2007) has also suggested that current education “prepares students for the world of the past, rather than the possible worlds of the future ” (p. 17) and needs to change its focus. Many governments and school reformers world-wide are communicating a need for education to change. In April 2009 the Government of Alberta hosted several community conversations in order for Albertans to share their ideas about the future of

education. The conclusion of the process produced a steering committee report entitled *Inspiring Education: A Dialogue with Albertans.* This particular report suggested changes towards a competencies-based, learner-centred curriculum to enable learners to become active participants in an increasingly knowledge-based and globalized society. The report stated that the role of teachers should change from that of "*knowledge authority* to an *architect of learning*" (Government of Alberta, 2010a, p. 7). The steering committee would have teachers adopt a constructivist perspective, become the overseers of learning activities, and consider the natural curiosities of the learner in their learning designs. In addition, the Government of Alberta acknowledged that technology should play a broader role in the classroom in support of learners' innovation and discovery. The Government of Alberta (2010a) stipulated that teachers in the future will need supportive Programs of Study with a less restrictive curriculum and more meaningful professional development. They advocate that structures need to be put in place that allow for regular exchange of ideas that will encourage teachers to understand their work differently.

Review knowledge, technology, and educational change.

What has emerged is an holistic understanding of the nature of knowledge, the emergence of the knowledge economy, and technological change, all touching teacher experience. In a process view, education does not exist in isolation; the knowledge economy, education, and technology all intersect on the map. Two things are evident. First, teachers need to learn to teach differently than they were taught as students (Friesen & Jardine, 2009; Gardner, 2007; Sawyer, 2008). Second, teachers will likely find themselves in teaching and learning situations making sense of unfamiliar technology more and more often. Questions then arise as to how to prepare infrastructure, administrators, and teachers to learn and anticipate change and future

developments with new technology as it becomes available. Hargreaves (2003) theorized that "if schools are to become real knowledge communities for all students, then teaching must be made into a real learning profession for all teachers" (p. 161).

Technology Integration

I have used the term, *entertain* after consulting several dictionary definitions. To *entertain* unfamiliar technology is to receive and take into consideration, to keep an open mind about its potential, examine its use, question its value, and consider its place in the classroom. Teaching today is increasingly complex work, partly because of the pervasive nature of technology and the accelerated rate at which it changes (Edwards, 2012; Willis, 2001). In addition, enormous funds have been spent on new and emerging technology in classrooms and yet technology has not had the expected impact in education (Derry, 2008; Glassett & Schrum, 2009; Schrum, 2005). Many teachers have received much in the way of technology, yet given the importance of technology in society, they have not jumped on the opportunity to consider new technology in their teaching. How best might this kind of teacher learning be enabled?

Mishra and Koehler (2006) argued that part of the problem with technology integration has been a tendency to look at technology only as a tool to master, and not how to use it on a practical level in the classroom. Amiel and Reeves (2008) believed that struggles with technology integration are due partly to the minor role educational technology research has played in transforming how technological tools are used in the classroom. In addition, Harris (2005) believed that technocentricity and pedagogical dogmatism have been far too common in teachers' professional development. Harris proposed that it is time, "to question whether professional, political, or personal penchants should dictate large-scale educational policy" (p. 110).

Several organizations such as the National Educational Technology Standards (NETS), International Society for Technology in Education (ISTE), and Partnership for 21st Century Skills have worked to develop standards to support teachers' meaningful use of technological tools. An ISTE (2011) report stated that "it is paramount that teachers possess the skills and behaviours of digital age professionals. Moving forward, teachers must become comfortable being co-learners with their students" (para. 2). As digital-age professionals, teachers acquire new technological skills, pedagogy, and specific technologies in various content forms. In this regard, Mishra and Koehler (2006) constructed a total package for teacher participation with Technological Pedagogical Content Knowledge (TPACK). The framework attempts to capture the essential qualities of teacher knowledge required for integrating technology with a focus on the affordance of each technology. TPACK captures the dynamic nature of the technology adoption process with an emphasis on the intersecting connections between each component of the technological, the pedagogical, and the content knowledge (p. 1026).

Characteristics of tech-savvy teachers.

Schrum et al. (2008) have used a mixed method approach including survey, interview, and focus group data to study what they called, "tech-savvy" teachers. Their study sought to examine how teachers who are already tech-savvy acquired the knowledge and skill they have, used the technology that was available to them, overcame challenges, and recognized the unique attributes of their personal or professional practice. Their study highlighted specific characteristics, challenges, and motivations that were indicative to teacher learning and adoption process. The study found that tech-savvy teachers' willingness to utilize technology was demonstrated through a sacrifice of personal resources. The tech-savvy teachers made considerable effort to learn about, acquire, and use technology with no support. They were

confident enough to overcome a fear of failure in using technology in front of increasingly tech-savvy students. The teachers also valued learning ahead of their personal pride or egos. Schrum et al. found that these teachers had a strong desire for continued or life-long learning. Many of the teachers responded that they used technology because it was fun and it engaged their students. These teachers realized that using technology had risks that would cost some class time but that the rewards outweighed the risks. The teachers felt that technology appealed to diverse learning styles and enabled them to control over their own learning. Another important finding was that technology was able to tie learning to the real world (pp. 6-8).

Schrum et al. (2008) concluded from the study that time and funding were a significant personal and professional constraint to the goal of implementing technology in the classroom. Yet even when time and funding were not provided, many of these tech-savvy teachers sacrificed their own resources so they could continue to teach with technology. In addition, many of these teachers were seen as the technology experts in their schools and spent significant preparation time supporting other teachers. The findings from the study provide an understanding that these tech-savvy teachers displayed "attitudes of continual learning, risk-taking and curiosity" (p. 12). Schrum et al. reported that it was clear to them that teachers who are not "tech-savvy" have a need for assistance.

New and emerging technology: Tablet computing.

I define new and emerging technology, such as the iPad, as any new technology adopted by society that has the potential to impact teaching and learning. Since I initiated the study, several new choices of tablets other than Apple's iPad have come on the market. Interactive whiteboards and laptops I consider to be established technology. The iPad according to Johnson, Adams and Cummins (2012) is viewed as a new type of mobile device and perhaps a new

technology in itself. The NMC Horizon Report: 2012 K-12 edition is the result of collaboration between The New Media Consortium, The Consortium for School Networking, and The International Society for Technology in Education. The purpose of the report is to identify and describe emerging technology such as tablet computing. The report states, "Tablet computing presents new opportunities to enhance learning experiences in ways simply not possible with mobile phones, laptops, or desktop computers, and is especially suited for one-to-one learning in the K-12 environment" (Johnson et al., 2012, p. 4). The report states that some teachers have found iPads to be excellent devices to enable students to become producers and creators, rather than passive consumers of content.

Alberta Education (2012) in a knowledge gathering and sharing event on new and emerging technology, such as the iPad, concluded that the top three reasons for introduction were to: 1) support students with unique learning needs; 2) meet the needs of every student with a universal design for learning; and 3) increase student engagement. Conclusions reached from the sharing event were that there are many educational benefits with iPads as well as issues in technical and device management, financing, and proprietary limitations. Additionally, iPads made a positive difference in classrooms when they were used in pedagogically sound ways and technical support was in place (Alberta Education, 2012, p. 5).

Along with the learning and teaching benefits associated with technology, there are also some challenges. In phase two (2011-2012 school year) Crichton et al. conducted a mixed method study of new and emerging technology in an iPad Project. Using surveys, interviews, direct classroom observations, and monthly professional activities in three schools (elementary, middle and high school), Crichton et al. (2012) found there to be an increased work load and a significant shift in the role and responsibilities for teachers when the iPad was introduced.

Teachers found management of iPad to be a rather daunting and time consuming task to learn how to master syncing, recharging, downloading apps, and sharing content created on iPads. Productivity apps such as SmartNote and Pages also required extra time for teachers to back-up the iPads on their computers. Teachers also needed to consider how students might share personal content created for assessment and collaboration. "Teachers also needed to learn how to use document cameras and other tools to support the use of personal devices in public settings" (Crichton et al., 2012, pp. 27–28). Most notably, the study suggested the devices were well received and well used. Over all, teachers reported a preference for a range of devices for teaching and learning. The study outlined ways to invite teachers to new and emerging technology matters. "Teachers need to be introduced to new technologies as learners first, before being called upon to use the technologies in their professional practice" (p. 29).

Review of technology adoption.

What has emerged in this section is an understanding of a need for teachers to develop a capacity to entertain new and emerging (unfamiliar) technology. It is important to note, with a new understanding of knowledge, that no technology by itself will promote significant pedagogical change without a willingness to embrace this change. Are we asking all teachers to become tech-savvy in order to adopt new and emerging technology? This highlights a need to support teachers to develop a willingness to try and envision change.

Sense-Making

Teachers make sense of new technology as an active process in relation to their own knowledge, beliefs, experience, and the situation in which they find themselves. Ketelaar et al. (2012) conducted a multiple method study of sense making and agency with 11 teachers in two secondary vocational schools. They set out to study teacher change with regard to the coaching

role through the lens of ownership, sense-making, and agency in a government-initiated educational innovation. Using both semi-structured and video-stimulated interviews Ketelaar et al. found that teacher sense making of educational innovation results from interaction between their own frame of reference and the perception of the situational demands. A teacher's experience is both unique and connected in the community of the teaching and learning landscape. The situational demands of the technology include the device and, most important of all, the total social set-up of the situation in which the teacher is engaged.

Ketelaar et al. (2012) highlighted three findings of teacher sense making in their study. First, the teachers were less resistant to innovation and a changed role if their frames of reference corresponded with the frame of reference of the innovation. Second, if teachers experienced enough agency to be able to find their own way in putting the innovation into practice, they felt a high degree of ownership regarding the innovation. Third, collaborative environments encouraged teachers to talk about the conflicts they experienced between the innovation and their own beliefs, thus lowering resistance to the innovation. A collaborative environment was important as it lead to a better understanding of the innovation, which in turn strengthened the teachers' feelings of ownership. The findings support the notion that schools with a focus on incorporating new and emerging technology "need a school leader who stimulates collaboration and at the same time respects the different identities of individual teachers" (Ketelaar et al., 2012, p. 281).

Review of sense-making.

What has emerged is that the process of sense-making of new and emerging technology begins with the capacity to entertain unfamiliar technology. Teaching is not a journey taken in isolation. Sense-making is embedded in a situation and can be cultivated in a supportive

environment. This highlights a need to support teachers, both as individuals and as a group, in sense-making of unfamiliar technology. What we know is that the greater educational community will benefit from an understanding of how teachers make sense of new and emerging technology.

A Need for a Framework of Enablers

Concerns about the slow adoption of technology by teachers are not new and sense making of new technology is an active process for teachers based on their own knowledge, beliefs, experiences and the social situation in which they find themselves. Given this, I present, based on the review of the literature, a framework of enablers aiming to examine teacher experience and highlight pathways for teachers to make sense of new and emerging (unfamiliar) technology. This framework outlines characteristics of internal affordance (teacher capacity), external affordances including effective professional development, and potential constraints.

Teacher capacity.

Denning and Dunham (2010) have stated, "anything we do in the world is enabled by our embodied capacity for action" (p. 80). A powerful learning cycle they believe is a continuing cycle of practice and reflection. Simply put during practice we engage in action with others. Then during reflection we step back and in a sense become observers of our actions. To complete the cycle of learning we then plan for the next round of action.

Making sense of new and emerging technology is also a cycle of practice and reflection (Denning & Dunham, 2010). To *entertain* unfamiliar technology is to keep an open mind about its potential, examine it use, question its value, and consider its place in the classroom. This process suggests a complex quality or capability connected to the individual teacher. As Schrum et al. (2008) suggested, teacher capacity is more than just skill. It is an intrinsic, internal

capability; an openness to possibilities; and a commitment to life-long learning. It is a willingness that pulls these attributes together with agency that Ketelaar et al. (2012) reported as a playful nature. It is an attitude of continual learning and risk-taking and a curiosity to build, explore, and learn with their students. Included is judgment— "the capacity not merely to respond passively to events but to make decisions actively in different contexts" (Derry, 2008, p. 508).

According to Levin and Wadmany (2008), teachers are key players in changing the educational landscape. Levin and Wadmany combined an exploratory and a collective case study of teachers' views on factors affecting effective integration of information technology in the classroom. They examined six teachers' views on the factors that affect technology use in classrooms. Levin and Wadmany studied the teachers both as a group and as individuals and found two developmental patterns. The first was concerned with the human factor as the source of influence on technology adoption. The second was concerned with the nature of the influence. In the study Levin and Wadmany revealed a complex relation between teachers' orientations concerning the conditions affecting technology use. The study recognized that in learning to use technology in schools, we must pay more attention to the conditions affecting the culture and profession of teaching. The study conceptualized the adoption of technology as a learning process for individuals and organizations with multiple factors. The study demonstrated that access to technology is required to ensure successful integration, along with "a complex web of interrelated factors and expectations within a didactic pedagogical task structure and an organizational and educational mindset" (p. 253). The teachers reported strongly believing that using technology was ultimately founded on their own internal learning process and their knowledge transformation and commitment to professional growth. However, the findings

highlighted that teachers' beliefs are also shaped by their experience, people they interact with, and artifacts in the environment. The study also suggested that one size did not fit all when looking to develop teacher capacity to work in technology-based environments. Levin and Wadmany concluded that teachers' learning of technology should be conceived as part of a culture of life-long learning, knowledge sharing, and peer interaction. They have suggested that a systemic, ecological, or a holistic view is important when studying change processes in teachers in order to understand why they might adopt classroom technologies. "Asking teachers to share their stories and reflect on their ICT integration experiences is another potential method for highlighting, understanding, and appropriately shaping personal beliefs regarding desired ICT practices" (p. 257).

Zhao and Frank (2003) have used an ecological metaphor viewing schools as ecosystems in their study of why technology is not used in schools. They suggested that an ecological perspective provided a powerful analytical framework for understanding technology use in schools. To test their framework, Zhao and Frank selected 19 schools and administered their survey to all school staff with a 92% response rate. They also conducted interviews with administrators and technology staff as well as conducting semi-structured interviews and observations in one focal school in each district with administrators and three to five teachers in each school. They were interested in understanding how institutional factors affected technology use and found that technologies were seen as either complementary or competitive. The teachers used computers in ways that addressed their direct needs, brought them maximal benefit, did not demand excessive time to learn, and did not require them to reorganize their current teaching practices. Zhao and Frank described a teacher-ecosystem interaction as help or pressure to use technology. Factors that helped teachers were opportunities for adaptation and teacher-computer

predisposition, such as a playfulness in experimenting. Teachers related to technology as individuals and members of a social system. Those who perceived pressure from colleagues were more likely to use technology for their own purposes, while those who had help were more likely to use technology with their students. Opportunities to play and experiment were found to be critical to technology implementation. The study suggested school districts would do well to allow teachers release time to engage technology and consider its applications in their specific contexts. With this ecosystem metaphor, the study concluded that change agents must take into account the extent an organism is prepared to accommodate change; the change agent must allow for opportunities of adaptation; they must allow for adaptation as a social process; and they must not overburden the system.

Studies have also shown that teachers who experienced agency within their work became active performers. Teachers felt in control of the choices they made based upon personal goals, interests, and motivations (Ketelaar et al., 2012; Walter & Gerson, 2007). Walter and Gerson studied a cohort of 25 practicing elementary teachers from 13 schools in a three-year professional development program. They focused on a collaborative group of six teachers from different schools. They used grounded theory analysis of video data to explore the question, "How do teachers' choices yield affordances that help build, justify, and connect their meanings of slope?" They advocated that the act of making purposeful choice is a fundamental component of learning. "In an agency-centered classroom, students and the teacher take turns negotiating the learning that takes place within constraints set by the teacher, the students, and the task" (p. 207). Teachers as individuals "need to experience a certain amount of autonomy and room for negotiation within their school" (Ketelaar et al., 2012, p. 275). In addition, Duffy and Cunningham (1996) stated that the constructivist environment affords students and teachers

opportunities to participate in purposeful choices within their community of learning. Intrinsic motivation to attempt the unfamiliar is bolstered as a result of providing a certain amount of personal agency.

From a slightly different perspective, Brown and Thomas (2008) have provided a framework called a questing disposition with three notions: a) Gilbert Ryle's notion of contingency and context; b) Michael Polanyi's idea of the tacit dimension; and c) John Dewey's understanding of inquiry. Dispositions do not tell us what *will* happen, only what *may* happen in certain circumstances. Dispositions can be tacit in that "we come to dwell in our dispositions and live through them" (Brown & Thomas, 2008, para. 7). As well, Brown and Thomas say some dispositions are directly tied to what Dewey described as *inquiry*. What is important is that the relationship between play and learning is both complicated and fundamental. One of the key traits of a questing disposition is this keenness, willingness, and belief that if you try hard enough you will find what you need along the way, that the world itself will afford the resources that are needed to explain any inquiry.

Zhao, Frank, and Ellefson (2006) added that capacity is a collection of knowledge, belief, and skills. For a teacher using unfamiliar technology this includes knowledge of: technology as a solution to problems, including beliefs, skills, and attitude toward technology; enabling conditions of technology use; and convenient access to support.

External affordance.

According to Ackermann (2004) if we believe, as constructivists do, that we learn by relating to others and acting in the world, then our capacity for action is not reliant solely on an internal capability. With this approach to learning, external affordances can be thought of as qualities in the teaching and learning environment, not what the environment controls, but what

the environment might *invite* an individual's capacity to act. These affordances are not seen as intrinsic, but rather as intentional affordances in the environment. According to Zhang and Patel (2006) the environment is not limited to the terrain, but also includes objects and structures within it. Affordances in the environment are what it offers, what it provides, what it furnishes, and what it invites. Similar to the process view, we must not only examine the individual teacher but also the interactions with the whole teaching and learning environment.

In addition Zhao, Frank, and Ellefson (2006) in a study of meaningful teaching and learning with technology found that affordances within the school environment could enable teacher capacity for experimentation with technology. Zhao et al. highlighted a need to provide teachers not only with access to technology, but also with time to play while developing a culture of collaborative learning communities and ensuring on-site mentors. Further, professional development opportunities they believed should be conducted in settings that are similar to the classroom context of teachers.

The age-old strategy for helping teachers to adjust to new priorities has been teacher professional development (PD) (Cunningham & Allen, 2010). Yet given new findings from the learning sciences about the nature of knowledge, teacher learning should be based on transformation of the individual rather than transmission of knowledge (Edwards, 2012). "The teacher who steadily learns from and about the work becomes, in time, a learned being" (Hansen & Laverty, 2010, p. 229). This notion of teachers as participants in learning rather than as passive receivers of knowledge rests in a constructivist framework (Duffy & Cunningham, 1996). MacDonald and Shirley (2009) also contended that the situation for teachers as participants can only improve when the "teachers themselves have opportunities to become more reflective of the multiple pressures upon them" (p. 26). How we *invite* teachers to participate in

change and professional learning, could enable them to be more prepared to entertain unfamiliar technology.

In a study focusing on effective professional development for meaningful teaching with technology, Zhao et al. (2006) outlined the characteristics of effective professional development experiences for teachers. They highlighted, "the need to understand the process by which teachers develop the capacity for teaching with technology" (p. 162). Zhao et al. conducted the study (2001-02 school year) with a goal to describe a set of qualities that characterized effective professional development programs. They surveyed technology coordinators and teachers in multiple districts. Their sample included more than 400 teachers. From their findings, they concluded teachers, require experience experimenting with technology so that they can make mistakes without potential embarrassment. Also, teachers require time to figure out what the technology can do, practice their skills at their own pace, and interpret the value in their own context. Zhao et al. also highlighted the importance of free experimentation to allow teachers to become comfortable in obtaining a more generative understanding of technology. Schools can also support teachers' experimentation by providing convenient access to technology-related resources, built-in play time for teachers during the school day, on-site technology mentors, and learning communities. Effective professional development efforts they state, "should aim at building learning communities among teachers and establishing social connections among teachers and support staff so that they can offer help and support to one another" (p.175).

Borko (2004) has found that professional development can help teachers construct understanding of content knowledge and change their instructional practice (p. 5). Contemporary reform according to Wood (2007), expands professional development and calls for teacher professional learning communities to build on the idea of "knowledge-of-practice" (p. 284).

Teacher learning communities then take on more constructivist principles that encompass the perspective of the learner in the form of professional networks, critical friends, study groups, and teacher-researcher collaborations. Teachers need these opportunities to collaborate in order to build on what they perceive to be their own needs. Wood notes that professional learning communities may promote deep and sustained thinking and analysis about education and offer opportunities to tap into tacit knowledge. Hargreaves (2003) also noted that professional learning communities seem to work best with high-capacity teachers in high-capacity systems.

Expanding the notion of teacher professional development, current design-based research deepens our understanding of teacher experience with unfamiliar technology, with a learning-technology-by-design approach. Researchers suggest learning by design will provide a context for learning and help teachers develop deep understanding (Amiel & Reeves, 2008; Anderson & Shattuck, 2012; Barab & Squire, 2004). Learning by design offers a vision of teachers not only as users of pedagogical knowledge but also its creators. Anderson and Shattuck (2012) describe design based research (DBR) as a methodology that seeks to increase the impact, transfer, and translation of education research. Reflection is seen as an integral component of all stages of DBR. It is designed as a collaborative process by and for educators. Anderson and Shattuck stressed the need for theory building to improve both practice and research within educational contexts. As Amiel and Reeves (2008) stated, "the ultimate goal of design-based research [is] to build a stronger connection between educational research and real-world problems" (p. 34)

The implication of this section of the literature review is that helpful elements of teacher professional development with unfamiliar technology are similar to meaningful learning with technology rooted in the constructivist tradition of education. This suggests that the constructivist approach to learning is not only applicable to students but to teachers as well. Both

learning events work best when situated in relevant context with a focus on subject matter and involve hands-on experiences that engage, such as solving real problems. Both involve reflection, support, and strong collaborative learning communities.

Exploring constraints.

Any discussion of technology adoption must also consider constraints (Johnson et al., 2012). Educational technology research has identified potential barriers to the successful integration of technology (Allen, 2008; Ertmer, 2005; Glassett & Schrum, 2009; Olsen et al., 2011; Schoepp, 2004). Some research has focused on internal individual characteristics of teachers, other research on external environmental barriers. As has been widely documented, teachers often lack the time and technology skills for effective technology integration. Ertmer (2005) suggested that teachers' pedagogical beliefs may be at work. However according to Allen (2008) research that focused on barriers has failed "to offer insight into the learning experience that invites practicing teachers, situated within their classrooms, to transform their frames of reference on practice" (p. 23).

In their conceptual exploration of distributed cognition, representation, and affordances Zhang and Patel (2006) described attributes of the environment as being coupled with the capacity of an individual that provides them with facility to act. Constraints are just part of the teaching and learning environment; they are the conditions and relationships amongst the attributes that make up the choices to act. Kennewell (2001) also pointed out that constraints are not the opposite of affordance. They are just painted lines on the road that both restrict and guide us. Kennewell described the relationship between affordances and constraints as didactical, "goal-directed actions in relation to tasks which have been designed to bring about learning" (p. 105). In this framework, learning is an active process that involves a change in abilities. A

classroom teacher may design learning tasks with both affordances and constraints. To achieve learning, effort is required. If the task is too easy or too hard, little learning will occur and affordances-constraints then need to be adjusted. The teacher's role is to adjust constraints and provide support in making learning possible, but not to trivialize the experience.

Zhang and Patel (2006) have suggested that constraints can be a natural part of a distributed framework of affordances between: a) external structures--information in the environment; b) internal perception of the situation--the decision-making abilities of the individual and ability (capacity) to act; and c) constraints. It is a relationship that generates action as it extends across the external environment (school) and the internal organism (teacher). Affordances and constraints should be considered in relation to the abilities of teachers and their ease or freedom in using technology in their classrooms. If there are simple constraints such as a program or application crashing and the teacher feels confident to trouble shoot, use a different program, or do an unplanned activity, then the teacher has what Zhang and Patel have called *allowable action*. If however there are the constraints in the environment that are outside the teacher's control, skill, or understanding, then allowable action is diminished. Perhaps the teacher has planned to show a video but cannot without upgrading to a newer version of the software to play it. The teacher with no administrator privileges to upgrade the software has no facility to overcome the constraint. In this case the teacher is likely frustrated while waiting for outside help to control the constraint. Zhang and Patel explained that affordances can be seen as distributed, guided, and constrained by the physical, cultural, and social contexts in which they are situated. Allowable actions can be negotiated if a teacher has facility, power, or understanding to address the constraints. The implication is to find ways of minimizing constraints in the environment and to increase the teacher's capacity for action.

Overview of enablers.

What the literature tells us is that through a framework of enablers, teachers can be invited to use their capacity to become learners who are focused on the process of learning, not on constraints. Gifting teachers with agency and a collaborative professional learning environment will strengthen their ownership and autonomy of learning. Learning opportunities for teachers are best situated in community, with authentic experiences distributed across internal and external affordances.

It is critical to consider teacher experience of unfamiliar technology with a holistic lens of the teaching and learning environment. If the goal of professional development is to enable teachers to adopt a more constructivist approach and adopt new and emerging technology, then teachers need time to live it and they need to know it takes time. Teachers need opportunities to work on solutions with others, reflect on their experience, and receive peer feedback (McCrory, 2006, p. 157). This highlights a need for school administrators to consider ways to invite attitudes of continual learning, risk-taking, and curiosity in teachers. In addition school administrators and school districts need to consider how to put structures in place that allow for regular exchange of ideas between teachers.

Teachers also need technology to work as intended or to understand why it does not. Perhaps then school districts ought to consider affordances for teachers such as more flexible infrastructures that allow for facility of use of new and emerging technology. Through external affordances teacher capacity can be cultivated to entertain unfamiliar technology.

Summary

A process view enabled me to provide a definition of technology and to explore many traditions of knowledge and technology as they related to education. Changes have been

highlighted in terms of our understanding of the nature of knowledge, the emergence of the knowledge economy, and technology, all of which have forced teachers to teach differently than they were taught as students. With this new understanding of knowledge, it is apparent that no technology by itself will promote significant pedagogical change without a willingness by educators to embrace these changes. There has been limited research investigating the dynamic nature of the technology adoption by teachers as process within the context of their teaching and learning environments. This review of the literature suggests a framework and a need to explore more deeply the following two questions:

1) How do teachers make sense of new and emerging technology to enhance teaching and learning?

2) How might these teachers' insights inform strategies to support the implementation of a new technology in teaching and learning?

Chapter Three: Methodology

The process of arriving at descriptive case study methodology is outlined in this chapter. It begins with the methodology rationale and an explanation of the research focus. The chapter includes a description of the procedures used to collect and analyze data, and a discussion of integrity and ethical considerations.

Methodology Rationale

Based on Lincoln and Guba's (1985) chapter entitled, "Designing Naturalistic Inquiry" I implemented the following emergent design in my study: the focus to be understood (context), the issues with the phenomenon (teacher experience), data collection (internal subjective), data analysis (open-ended), and finally the end product of understanding involving a process of interpretation (lessons learned). The essence of the case was not bounded by a *problem* so much as by the *issue* of making sense of unfamiliar technology (Stake, 1995). The intent was to capture in a broad context the openness of experience in a natural setting, adopt an interpretive approach to data, and consider the subjective meanings that participants brought to their situation (Clough & Nutbrown, 2002) as well as to look deeply at the unique context of the experience of three teachers with an unfamiliar technology, in this case, Apple's iPad an interactive, mobile, touch-screen tablet device. It was anticipated that lessons learned from this case study might contain the seeds of understanding in how to support other teachers who must contend with new expectations for teaching and learning, along with unfamiliar technology.

The nature of this understanding required a methodology with an emergent design that supported an open-ended interpretive process (Creswell, 1998, 2009). What came from getting to know the *case* was a description of: the role of teacher as *architect of learning;* a framework of

enablers for teachers to make sense of unfamiliar technology; and ideas for future considerations to support teacher capacity.

The critics of case study argue that it is not a methodology but rather a method. For example, Willis (2008) argued that case study is really a lot of methods gathered up and bundled into one lumpy bag labelled "case study" (p. 210). Willis pointed out that case studies do not have a specific type of data associated with them and often involve multiple types. He stated that case study is "more of a method of organizing and reporting the results of your study than it is a method of collecting data" (p. 211). Walcott (2001) also remarked that the problem with case study was not that it did not fit in qualitative research but that it fit everywhere. Walcott believed case study was better regarded as a form of reporting than as a strategy to collect data. "As a format for reporting, it is not only convenient but preferred" (p. 91).

However, Creswell (2009), Merriam (2009), Stake (1995), and Yin (2009) embraced qualitative case study as a sound methodological choice for an in-depth descriptive study of a phenomenon. An advantage of case study methodology was that it allowed the use of multiple sources of data to look at the issue of teacher experience holistically in its natural context. Case study methodology was also versatile as it allowed for an emergent process to collect and make sense of data. All of these attributes I believe assisted me in capturing and honoring the three teachers' voices in the study.

This research in case study methodology was grounded in three key features: a) the *issue* was the sense making of three teachers of an unfamiliar technology in the role of architect of learning; b) the *case* was a system bounded by time and the context of the iPad experience; and c) the data collection consisted of multiple sources of information that provided rich description. The goal of the study was to gain experiential understanding of the issue through rich

description. A descriptive case study specifically fit the intent: to develop an in-depth analysis and description of teachers' experience and context within a bounded system. In addition the hope was that lessons learned might inform and expand understandings of teacher experience with unfamiliar technology to a greater educational community (Creswell, 1998; Merriam, 2009; Stake, 2006).

Research Focus

The study recognized that the experience of sense making involved more than teachers simply physically finding room on their shelf for a new technology. As the researcher, I focused on the interactions between the other available technology, the teaching and learning process and the process of sense making not just for the individual but in the social context as well. I designed the study to capture happenings, expand knowledge, and inform broader understanding beyond the case (Merriam, 2009; Stake, 1995). With this pragmatic focus, the research had several synergetic goals: a) to describe teacher experience with unfamiliar technology and the context of their experience; b) to explore possible motivations, tensions, and affordances to entertain unfamiliar technology; and c) to interpret these events as lessons learned in order to develop ideas for support and further study. Knowledge was viewed as a "tool for organizing experience [which] is deeply concerned with the union of theory and practice" (Schwandt, 2007, p. 240). Underpinning my approach to this case study was a constructivist theoretical framework: that knowledge is a social and interpretive process. From this perspective the study was descriptive "without expectation of causal explanation" (Stake, 1995, p. 38). It was not designed to test theory, compare, or measure anything quantitatively (Merriam, 2009).

Study Participants

The study took place in a Western Canadian city. The teachers who volunteered for the study were also participants in a separate research study referred to as The iPad Project (Crichton et al., 2012). Principals of schools that wanted to participate in The iPad Project were required to apply to the district Information Communication Technology team. Three schools were selected and the principals in each school selected a limited number of willing teacher participants. I was not aware of the selection process. Teachers, principals, and students were given a collection of iPads and ongoing professional development as well as IT support to facilitate its use in the classroom. The purpose of The iPad Project was to gain an understanding of the infrastructure required to support handheld devices in K-12 classrooms. I came to know of the project when I supported the research team. The iPad Project took place over the entire school year, it had begun prior to and it lasted longer than my case study.

The present study, as a qualitative case study, focused on, "learning the meaning the participants [held] about the [issue]" (Creswell, 2009, p. 175). The study participants were not randomly selected and are identified with pseudonyms. I approached three teachers for the case study as they were willing to entertain unfamiliar technology in The iPad Project. Three participants are considered sufficient for naturalistic generalizations (Stake, 1995). Two of the three teachers agreed to participant observation. I supported these teachers with many classroom activities and recorded my observations with written notes, digital images, and digital audio. One participant did not agree to participant observation in his classroom but did agree to audio recordings of his voice during the interview, informal conversations, and the Professional Learning Committee meetings. All three agreed to member checking.

To gain access to the teachers' classroom experience, I took the following steps:

1) The principal investigator of the iPad Project introduced me to the principal at one of the participating schools. We met with the principal to explore a fit for my study.
2) The principal of the school then informed the two teachers at her school of my study, at first they declined participant observation but did agree to an interview and to listen to my research focus.
3) I returned to introduce my research and conducted a structured interview with the two potential teacher participants with the hope that they would agree to participant observation.
4) After the interview, Sarah (pseudonym) consented to prolonged participant observation and consent was later obtained from the school's district superintendent for classroom visitation. Thomas (pseudonym) agreed to recorded interviews and conversation but not to participant observation.
5) In an effort to provide for a greater variety of experience, a third teacher, Alex (pseudonym), also from The iPad Project, was approached by another member of The iPad Project team. After an explanation of the goals of the study, he agreed to participant observation. Alex was at a different school, so for convenience, participant observation began after concluding participant observations with Sarah.

Data Collection

As the researcher, I was guided by Creswell's (2009) recommendation to gather data from multiple sources directly in the school environment. Triangulation using multiple sources can also enhance the validity and reliability of the study (Merriam, 2009). Evidence was collected from a range of sources: face-to-face interviews; participant-observation; documents; and artifacts of both digital and hardcopy classroom documents.

Interviews

School One.

Located in a Western Canadian city, School One was an elementary school built in 1967 with a total population of 287 students. The school accommodated children Kindergarten to Grade 4, along with two special needs classes.

The initial source of data was a semi-structured scripted interview (Appendix A). As Stake (1995) articulated, "much of what we cannot observe for ourselves has been or is being observed by others" (p. 64). Initially Sarah and Thomas had only agreed to an interview; it was conducted before Sarah and Thomas had considered participant observation. Sarah and Thomas (teachers) were introduced to the focus of the study and invited to participate in the research. The interview process was guided by Creswell's (2009) work as it involved scripted open-ended questions. The questions were broad and general in nature. The intent was to guide the conversation towards gaining basic descriptive information about the teaching and learning environment and to make them feel comfortable with my research presence in their classroom. Of particular interest was their philosophy of learning and of technology, as well as their early experience while engaging the iPad for teaching and learning. Since the point of the initial interview was to open an experiential understanding and begin a narrative relationship, the tone was explorative and responsive (Seidman, 2006).

Half way through classroom observation at School One a semi-structured interview was conducted with Sarah for the purpose of clarity of observations. I sat with Sarah after school hours to have an uninterrupted conversation to clarify some of my observations and fill in some gaps in my understanding of her experience. A final semi-structured interview was conducted two months later. I spent that afternoon observing in her class one last time and stayed after

school hours to conduct another uninterrupted interview as well as to share emerging themes and to seek clarification of the data after the first round of coding.

School Two.

Located in the same city as School One, School Two was a larger and newer middle school built in 2003 with a population of 750 students. The school offered English programming for students in Grades 4 to 9 and French Immersion to students in Grades 4 to 8.

During classroom observation at School Two with Alex (teacher), several informal conversations were recorded for the purpose of clarity of observation. The same scripted interview with open-ended questions was conducted during the fourth week of participant observation, not to begin a narrative relationship as with Sarah but to look for possible patterns and themes between the two settings. Finally, as with Sarah, a follow-up, semi-structured interview occurred with Alex one month later for the purpose of sharing emerging themes and clarification.

Observation

During direct observation in the participant observer role, I initially focused on sensory details of description of the teaching and learning environment (Stake, 1995, p. 86). My first observations were focused on interpreting the general context of the classroom and looking for how technology was used in general, as well as what tools were available and any barriers for the teacher. I observed the normal comings and goings of the students during the school day but focused on the teacher's experience. My observations were recorded using special notepaper and a digital pen as well as a digital camera. My role as the researcher soon shifted to participant-observer to support the teacher with various classroom activities. Merriam (2009) noted, "Researchers are rarely total participants or total observers. Rather, there is often a mix of roles"

(p. 125). I supported the teachers much like a volunteer. I responded to the teachers' requests by supporting struggling students and helping to clean up after activities. I also used my knowledge of digital filmmaking and Desire2Learn™ (D2L) to support the two teachers with learning activities. Participant observation assumes immersion and Schwandt (2007) supported the thinking that it was the best way to develop an understanding of another's way of acting in the world.

To focus my observations, I went into the classroom with an observation protocol consisting of three broad themes: demands on teachers to become architects of innovative learning environments, potential barriers for innovation, and possible pathways to innovative learning environments. During the observation period at School One I created and modified three versions of a code matrix of these three themes in spreadsheet form. After completing observation at School Two, I adapted a fourth version that I used during the first round of coding. Observation, along with greater understanding of the data from the coding process led me to greater specificity in reporting the observations. For example, I first began by examining teacher experience using the lens of innovation, but in time this changed because my observations led me to see technology more as an experience with the unfamiliar than as an innovation. In addition, my observations suggested to me that confounding variables did not seem to be barriers for these three teachers.

Documents and Classroom Artifacts

Researcher-generated documents included a personal journal that was used to reflect on the research process and to capture personal thoughts that were triggered during classroom observation. The same journal was used to expand on these reflections and track the progress of

interpretations during the dissertation writing process. Merriam (2009) maintained that such documents may "contain clues and startling insights into the phenomenon under study" (p. 149).

Artifacts included: a graphic organizer for student use from School One, student-created newspaper from School Two, and teacher-created videos also from School Two. Yin (2009) has explained that while generally less relevant, artifacts can also be an important component in the overall case. Stake (1995) advised a similar line of thinking: to be organized, yet open for unexpected clues. Artifacts collected for the study addressed two foci of the research. One of the goals of the study was to describe the experience of teachers in the role of *architects of learning*. The architect of learning is a metaphor for a constructivist teaching and learning process. One responsibility of this role was to provide personalized learning and multiple forms of assessment. By examining the actual graphic organizer for student use, a broader perspective was achieved than through observation alone. Another responsibility for the *architect of learning* was to provide opportunities for their students to read about and to express themselves with current and emerging information and technologies. Examining the actual student-created newspaper gave a broader perspective than would observation alone. Another goal was to describe teacher capacity to engage with unfamiliar technology. Three different teacher-created digital videos were collected as evidence and analyzed according to the three themes established during data analysis.

Data Analysis

Structured Interview

As stated earlier the initial interview questions were broad and general as a means to introduce myself and gather descriptive data about the teachers' context and experience. In an effort to develop experiential understanding, Stake (1995) advised a narrative account involving

rich description “emphasizing time, place and person” (p. 87). Miles and Huberman (1994) suggested creating a provisional “start list” of codes prior to field work (p.58). Following these conventions, I created a digital matrix in spreadsheet form to organize the structured interview data. Two versions were created after the interview was conducted. This was done during the observation period at School One. A third version was created during the first round of coding after classroom observation was concluded at both schools. An example (Figure 1) of the second version before coding included descriptive headings such as settings, characters, topics discussed, highlights, tone, and tensions to help organize the data. The matrix also included links to digital evidence collected (observation notes and audio clips).

Figure 1 *Interview digital matrix version two*

Context			Themes			Evidence:
Setting	Characters	Tone	Topics	Highlights	Tensions	Recordings
Learning Commons.	Teacher_1 and Teacher_2	Positive, these teachers seem tired but proud of the work they do and their students. They seemed eager to share their experience today.	•Introductions	This was our first meeting, I brought food to help establish a relationship; at the end of the day teachers are tired and hungry.	I am uncomfortable with the newness of my role as researcher	
			•Philosophy of Education	What school is for: Socially learn how to learn and to navigate through the world. Important to be confident learners. Foster a collaborative community Classroom is a reflection of the teacher. Teachers looking for evidence of journey in student work. Final product should reflect the journey. Inquiry question for the year: How do we connect to community? Students need to be adaptable, efficient, thoughtful, discriminating in their choice of tool, How are you going to get at information and how are you going to use it?	Time These two are busy teachers; they even had clean up duty after our interview.	
			•Philosophy of Technology	They need technology to support a learning need. Teacher_2 says he needs a tool to help us get to an end, a tool to get at find information. Students need to become proficient at life skills like reading and writing, technology can support all learners and reduce limitations. We use tools such as, digital cameras video (photobooth) smartboards D2L, software -comic life, assistive technology, inspiration, Caster for iPad, iLife suite. Evaluate the tool through the process of inquiry with a	**Easy of Use** I want it to work! We need it to be simple. **Choice** I want my students to have choice in the tools they use. We are very locked down here! Time for teachers to learn new technology is limited. **Time** You have to really want to learn in your own time.	

An audio smartpen with a built-in microphone and speaker captured the structured interview (as well as conversations and other classroom happenings). The pen was used to

transfer hand-written notes and audio clips directly to the computer. This allowed for careful documentation of dates and times of each event. In addition, the software allowed for easy organization and export into iTunes where the whole interview was *clipped and coded*. Crichton (2009) described the process of *clipping* as cutting long recordings into small segments. These segments were then organized in the digital matrix where they were labelled using emerging *codes*. Codes are labels for assigning units of meaning (Miles & Huberman, 1994). Once data was organized, it became easy to listen repeatedly for patterns.

While working through the clipping and coding process with the interview data, the three themes emerged and over time sub-codes were added and modified to each of these three themes. A thematic analysis of the data provided a basic understanding that eventually led to more refined themes: a description of the architect role and responsibilities, enablers including teacher capacity, and possible constraints to technology use. The classroom was entered with an observation protocol as described above (a working collection of codes). The one-page start list was built from this initial coding and expanded during and after participant observation. This list assisted in focused observations of these particular variables of teacher experience.

Participant Observation

Direct interpretation of classroom observation was based first on looking for the themes and later on the frequency of their reappearance (Stake, 1995). The learning events within the classroom were then brought to life with narrative descriptions in daily notes. As Stake (1995) suggested, qualitative researchers collect narratives and "represent happenings with their own direct interpretation and stories" (p. 40) in the effort to sharpen the search for understanding.

In a constructivist world view "meanings are constructed by human beings as they engage with the world they are interpreting" (Creswell, 2009, p. 8). The initial first theme of

demands on teachers was constructed from information taken from the Government of Alberta's *Inspiring Action on Education* (2010b). While the observation protocol guided the initial observations through a lens of innovation, the continual revising of observation data made me shift my thinking away from how the teachers used technology to how they experienced it with their students. The teachers' experience that I observed was more about being flexible with everyday constraints than about barriers to technology use. Thus a second round of coding was applied to classroom observation data. This data required a new, more refined matrix to reflect this understanding (Figure 2).

Figure 2 *Classroom observation data matrix version two/School One*

Setting March 22, 2011	Character's Activity					Conflict Source			Teachers role						Constraints					Enablers					
Time	Place	Student	Teacher	Teaching Tool	Teacher Chair	External Structure	Tool Design	Internal ability	1.1	1.2	1.3	1.4	1.5	1.6	1.7	2.1	2.2	2.3	2.4	2.5	3.1	3.2	3.3	3.4	3.5	3.6
8:30 AM																										
9:00 AM	Gym			white board										1												
9:15 AM									1				2													
9:30 AM	class math	listen	instruct	food flyers chart paper	teacher				1	2				1		1	1						1			
9:45 AM				visual journal	shared									1	1											
10:30 AM	recess				NA				1	1							2						1			1
10:45 AM	class floor	SOW	computer	chart	student										1											
11:00 AM	floor	listen	instruct	visual journals		network down			1	1			1					1					1			

Figure 2 is a partial snap shot of the second version of the matrix created after observations in both schools were completed for School One's observation data. Two spreadsheets were created, one for each school. Each days data was summarized and entered under separate tabs within the spreadsheet. This was a way of organizing the digital data and the still emerging themes. This process was repeated separately with the observation data from School Two. This became the first step in moving from description towards understanding. This matrix display was also helpful for understanding the flow and connection between the two settings as well as for representing the frequency of the emerging themes. At this point, my thinking of the first theme had shifted. I no longer thought of it as external demands. Instead, I began looking at it as a role that these teachers had the capacity to play. However I still had the

mindset that the constraints should be situated between the architect of a learning role and enablers for technology use.

As Stake (1995) articulated, the search for meaning relies on looking for patterns, for consistency, and for the reappearance of themes. After one month of participant observation, when data collection became repetitive, classroom observations were concluded at School One and initiated at School Two. And after one month of participant observation at the second school, when the sub-codes stabilized, I concluded that the field was saturated. Miles and Huberman (1994) have described this sub-coding as a way of grouping emergent themes into smaller sets to develop understanding.

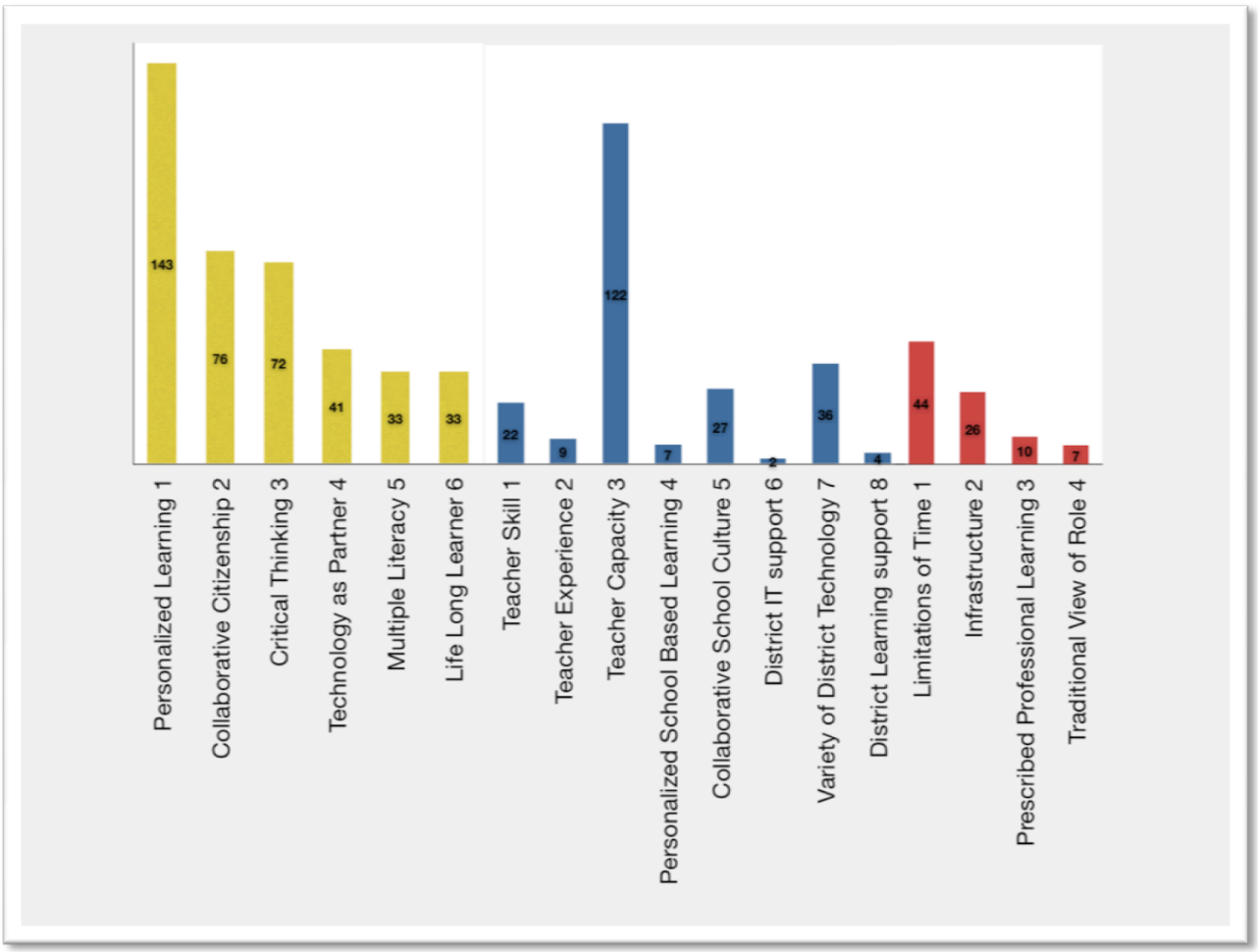
Ezzy (2002) and Merriam (2009) advised researchers to begin data analysis at the time of collection, so raw data (images, audio, and observation notes) were collected in the classroom Monday to Thursday. Parallel to the matrix, every Friday each day's notes were typed out and expanded with the support of revisiting digital audio and images. These document files were named according to date and organized by school location in a file structure. These daily notes included thumbnails of photos taken that day and digital links to clipped audio recordings and other digital artifacts. Digital images were also coded according to the three themes and organized in iPhoto, while digital recordings were coded and organized in iTunes. I followed Merriam's (2009) suggestion in making the daily notes highly descriptive and reflective. They included descriptions of the setting, the people, and the activities as well as direct quotations and observer comments. While attending to the typed notes I was surprised at the extent of the impact of reviewing photos and listening to the intonation, the passion, pauses, and inflections of each participant's voice in the clipped audio recordings. This process became a way to "experience the experience" (Clandinin & Connelly, 2000, p. 80). Crichton (2011) explained that

this method reduces the need for transcription while also reducing the concern over flattening the rich nuance and intricacy of the experience into a flat text format. In the end classroom observation notes were printed out and manually color coded by hand, line by line, in what Miles and Huberman (1994) called an "inductive coding technique" (p. 58). These codes were then inputted into a third revised matrix for classroom observation. A third spreadsheet was constructed for the combined data and analyzed for frequency and relationships. The frequency of themes referred to how often they were observed. I did not make any assumptions as to why some themes were observed more than others. As a qualitative researcher I was more interested in how the two schools were similar than in how they were different.

Digital artifacts were also organized on a computer by date and location. Each of these items was coded and linked in the matrix and notes. Other hardcopy artifacts were kept in the research binder and coded in the daily research notes.

The final stage of data analysis involved drawing out meaning from the observations and interpreting all of the data as "lessons learned" (Creswell, 2009, p. 189). As Richardson and St. Pierre (2008) have explained, writing is a form of inquiry and a method of knowing. During the process of writing this chapter some of the sub-codes shifted one more time leading to a fourth and then a fifth version (Appendix B). This fifth and final collection of the themes and sub-codes were then inputted into a final matrix (Figure 3). At this point I became aware that enablers were more important to the architect of learning role than I had previously thought and I placed them second as represented in Figure 3.

Figure 3: *Fifth and final total frequency of themes*



Integrity Of The Study

My goal in this study was to construct valid interpretations and reliable understandings based on the ethical treatment of data collected in a natural (classroom) setting. I looked to Creswell (2009) to develop a validity strategy. Lincoln and Guba (1985) referred to this process as "demonstrating the trustworthiness of inquiry guided by the naturalistic paradigm" (p. 290). The rigour of this qualitative research followed multiple strategies to enhance the validity and reliability in order to produce authentic and trustworthy descriptive conclusions (Creswell, 2009).

Internal Validity or Credibility

In qualitative research internal validity deals with the question of how research findings match reality (Merriam, 2009, p. 213). The study used multiple strategies by following Lincoln and Guba's (1985) five credibility techniques: prolonged engagement, persistent observation, triangulation with multiple sources of data, external checking through daily debriefing, and member checking.

Prolonged engagement and persistent observation.

Prolonged engagement and persistent observation involved data collection over a month of time and included repeated classroom observations. Participant observation occurred four days a week, over four weeks, in each school. The emerging findings felt saturated as the same things were heard and seen over and over again (Merriam, 2009).

Triangulation.

Triangulation of multiple data sources meant comparing and cross-checking data collected through observations over time (Merriam, 2009). In the study this was done with three different teachers at two different schools. Data were gathered through the case study approach through interviews, observations, field notes, documents, and classroom artifacts. Data were collected from the three different participants at two different schools over a total of four months. Themes were established by converging the data and checking often for drift or shift in definition of codes thus strengthening the reliability of the study as suggested by Creswell (2009).

External checking.

Steps were taken to ensure that the documented events were not imagined. Observations and emerging themes were discussed with Sarah and Alex through informal debriefing

conversations daily. In addition, the third version of frequency of themes was also shared with and explained to Sarah and Alex during my final interview.

Member checking.

After the completion of the research text, participants judged the accuracy of interpretations with a final member check as described by Stake (1995) and Creswell (1998). I asked each of the three teachers to read though the findings, check for accuracy and give feedback. All responded and provided comments of clarification.

Merriam (2009) described the strength of internal validity as uncovering the complexity of human behaviour in order to understand it within its context and to reach a holistic interpretation. To further strengthen the validity of the study, I had several meetings with my advisor in an effort to audit the research process and to provide peer debriefing in a "devil's advocate" role as described by Creswell (1998).

External Validity or Transferability

A case study is a tool to understand a real life phenomena in context (Yin, 2009). This case study was not an attempt to predict the future or to make broad generalizations but instead to understand the three teachers' experiences and to look for what Jardine (1992) referred to as a "family resemblance" (p. 55). External validity is concerned with the extent to which my findings can be generalized or transferred to other situations (Merriam, 2009). Following Stake's (1995) notion of naturalistic generalization I was concerned with producing enough descriptive information for the readers vicariously to find a degree of resemblance between the case and their experience.

Reliability

Reliability in qualitative research refers to the extent to which the research findings can be replicated (Merriam, 2009, p. 220). Reliability in this case did not mean replication in the traditional sense (Yin, 2009). Rather than expecting others to get the same results, I was concerned with understandings that made sense, given the description of how the data was treated. In an effort to ensure this, overlapping strategies were used as outlined by Merriam (2009). Triangulation and peer debriefing were already discussed under Internal Validity.

The study was seen as reliable as it attended to what Lincoln and Guba (1985) called *dependability and consistency.* Behaviour can be deemed reliable if it is consistent, dependable, and predictable. As human behaviour is never static, the research was somewhat emergent in design and not tightly prescribed (Creswell, 2009). While I did have an initial research plan with scripted questions for interviews, the questions were open-ended to allow for the participants to speak freely about their experience. Additionally while the formal research questions did not change, the goals during the study expanded to include the use of the term *unfamiliar* to better describe the experience with new and emerging technology. The key idea was to learn about the issue reliably from the participants, not to test a theory.

Audit trail.

In the study, I provided a detailed explanation of how the data were collected and organized digitally and described the process of how the themes emerged throughout the course of the study. In addition, I kept a personal research journal in which methodological decisions, reflections, and expanding questions were recorded.

Investigator's position.

Data quality checks, as outlined in Miles and Huberman (1994) were made. For example, I documented my procedure in my research journal and I dated the five versions of the themes making sure there was no disconnect in the emerging codes. I checked audio recordings repeatedly and transcripts to make sure they did not contain mistakes. Bias was also clarified; assumptions, prior teaching experience, and theoretical orientation to the study were also examined within this dissertation.

To further strengthen reliability as I progressed in the study from describing to explaining, a three-level analytic progression was followed, as laid out in Miles and Huberman (1994). First, interview recordings were reconstructed as written notes, then summarized and coded with emerging themes in a matrix. Second, themes were identified, tested on observational data notes, and re-coded in a more refined matrix. The third step was to construct an explanatory framework from cross-checking tentative findings of all of the data. Crichton (2011) also argued that the clipping and coding process (outlined in Data Analysis) further supports the integrity of the participants' voices and their lived experiences.

Boundaries For The Study

The constructivist worldview in the study presupposes that individuals seek understanding of their experiences in the world through interactions with others (Creswell, 2009; Crotty, 1998). The construction of these understandings comes from first hand experience and from what others tell us about the world (Dewey, 1916; Stake, 2006).

In qualitative research, the researcher is the primary instrument in the collection and interpretation of data (Creswell, 2009; Denzin & Lincoln, 2008; Merriam, 2009). Creswell (2009) suggested a position within, to acknowledge how interpretations flow from the

researcher's personal, cultural, and historical experience. As the researcher, I recognized that my own background as a teacher shaped the questions and the interpretations made. In this regard Creswell highlighted a need for self-reflection to clarify bias. It then became important to explore any prior assumptions in order to create an honest narrative for the readers.

Assumptions for the Study

I approached the study with a number of preconceived, intertwining assumptions. The first was that technology changes quickly. Because of this, teachers will regularly come into contact with unfamiliar technology. The second assumption was that the reworked role as described by the Government of Alberta (2010) requires both new and experienced teachers to use technology in ways that they were not taught as students. The third was that these two major changes, both technological and pedagogical, lead to tensions or constraints for teachers in making sense of unfamiliar technology.

Participant Observer

The participant observer role required a negotiated relationship between observer and observed. Self-reflection about this relationship revealed several concerns of possible bias. The focus of the inquiry came from personal experience similar to that of the participants. In clarifying my bias, as suggested by Creswell (2009), the first concern was the possibility of over-familiarity. Moving back and forth between the roles of researcher and teacher required different perspectives. I was concerned that I might lead participants to say what I wanted, or that they might say what they thought I wanted to hear. In addition, my experience with technology as an educator was largely as a tool to support knowledge construction. A second concern was misunderstanding or ignoring valid direct instructional uses of technology. I dealt with these concerns by constantly checking with the three participants. Flyvbjerg (2006) pointed out that all

forms of research are prone to a tendency to confirm the researcher's preconceived notions. The advantage, he says, with qualitative case study "is that it can close in on real-life situations and test views directly in relation to phenomena as they unfold in practice" (p. 428).

Delimitations of the Study

Delimitations of the study included the following:

1) The study was an examination of a specific population and setting, namely the experience of three teachers in two different schools, rather than a cross-section of teacher experience.
2) The study focused on teachers who were willing to entertain unfamiliar technology within The iPad Project.
3) The study focused on pedagogy and the teacher's constructivist role as the *architect of learning*.
4) Length of time for the data collection was from February 2011 to May 2011.

What Worked Well with Case Study Methodology

Case study methodology allowed me to:

1) Develop an in-depth understanding of the *how* (a framework of enablers) of the phenomenon within it natural classroom setting.
2) Develop practical context-dependent knowledge of teacher experience.

Limitations of the Study

Limitations of the study included the following:

1) Due to the single case study design, the study represented only a snapshot of time of teacher experience. While difficult to generalize, rich description provided the opportunity for transferability of the research findings. Nonetheless, the lessons learned

from the three teachers were applicable to a larger educational community (Stake, 1995; Yin, 2009).

2) My own biases about new and emerging technology in teaching and learning may have limited interpretations of events.
3) Not being able to attend all teacher activities, such as staff meetings, limited data collection.

Modifications

Based on what I learned during data analysis, what I would do differently in carrying out case study in the future would be:

1) To provide participants with more opportunity to express themselves through the use of more open-ended questions.
2) To be more diligent with my research journal to better capture the emergent process when revising codes.

Ethical Considerations

A research proposal for the study was approved by the supervisory committee in the summer of 2010; an application for ethical approval with supportive documents was submitted, and then approved by January 18, 2011 by the University of Calgary's Conjoint Faculties Research Ethics Board. Additional approval was sought and received from the schools' district superintendent on February 23, 2011 for classroom visitation. The teacher participants in the study were informed of the goals of the research. The teachers gave their consent for participation in the research and signed the informed consent for participant observation to take place over a prolonged period of time. The teachers participation was voluntary and they were

aware that they had the right to withdraw from the study at any time. Member checks were also conducted to allow participants the opportunity to review interpretations of events.

Summary

A case study methodology was used to collect descriptive qualitative data from four data sources. The data were analyzed using a continuous interpretive process as it moved through three phases of summarizing, development and refinement of themes, and examination to convey an holistic understanding of the research findings. Merriam (2009) stated "conveying an understanding of the case is the paramount consideration in analyzing data" (p.203). Validity and reliability were addressed using appropriate procedures and processes for a descriptive case study methodology.

Chapter Four: Findings

The following overarching questions guided the research: *How do teachers make sense of new and emerging technology to enhance teaching and learning? How might these teachers' insights inform strategies to support the implementation of new and emerging technology in teaching and learning?*

The methods of data collection used to address these questions were interview, observation, and informal dialogue. Data were collected from three different teachers and two different school sites over a four-month period. Since data from the first site was collected and organized separately before beginning data collection at the second site, an interpretive bricoleur method was required to weave the data from the two sites into a rich description. Denzin and Lincoln (2008) described this method of analysis as a piecing together of a set of representations. It was pragmatic, strategic, self-reflective, and interactive.

This chapter begins with the classroom learning context. The teachers were identified by pseudonyms. The three themes that emerged from the data are: 1) a description of the architect role and responsibilities for teachers; 2) enablers, and 3) constraints for engaging with unfamiliar technology. It concludes with insights to inform the greater educational community.

Classroom Learning Context

The iPad Project

As explained in Chapter Three, the teachers in the study were participants in The iPad Project. The purpose of The iPad Project was to gain an understanding of the infrastructure required to support handheld devices in K-12 classrooms within one school jurisdiction. The iPad Project took place during the school year 2011-2012. Each participating school received a

collection of 17 iPads to share among participating teachers, their students, and the principal. The iPad Project also provided ongoing professional development to participating teachers and IT support to the school to facilitate the use of this technology in teaching and learning. At the time of the study, iPads were completely new to the teaching and learning environment as they were first available in Canada only in the Spring of 2010.

School One

Sarah and Thomas (pseudonyms) team-taught two multi-aged, Grade 3-4 classes. They were in closed classrooms located next to each other. They were the only teachers to have iPads in the school. Sarah, in her fifth year of teaching, had 26 students. Thomas, a new teacher on a temporary contract, had 28 students. I did not observe in Thomas' classroom. The two teachers planned inquiry projects together. Their work with students was guided by the following overarching inquiry question, "How do we connect as community?" These two teachers organized their timetables so that each classroom could use the entire collection of iPads during the English Language Arts period. During this time students shared an iPad with their learning partner. At other times of the day, the iPad collection allocation was flexible. Sarah took responsibility for updating the iPads as needed.

The observation period was for the month of March, 2011, Monday to Thursday with one additional visit in May. I was most often in Sarah's classroom but also visited other classrooms, the gymnasium, the art room, hallway learning spaces, and the learning commons (library). During this time, I observed many activities, including: teachers' professional learning community (PLC) meetings, English language arts, mathematics, social studies, student-of-the-week, lunch, and a field trip. English language arts included paper and pencil activities as well as digital storytelling using the iPad. Mathematics took the form of problem-based inquiries and

centre activities. The centre approach is a collection of activity-based tasks that students rotate through in small groups of two to four students. The social studies activity was referred to as The Community Project. It had an interdisciplinary inquiry focus of mathematics, science, health, and social studies. The Community Project was part of a year-long inquiry in which the students explored the community in which they lived. The segment that I observed focused on structures within the community. Sarah also used the online learning management system, Desire2Learn™ (D2L) to support her students' projects. D2L allows a teacher to create and organize web-based content, monitor student participation, and provide students with the ability to use interactive features such as threaded discussions, all of which are described in more detail throughout this chapter.

At first glance, Sarah's classroom had a conventional look. At the back was a whiteboard where the day plan was written; above it was an alphabet strip. On the left side of the room was a chalkboard, a map of Canada, a clock, and cupboards with a sink. The right side had a bulletin board to display student work along with teaching supports, such as a word wall-- all things one typically sees in an elementary classroom. What gave this classroom a contemporary feel was the way it was organized and the interactive whiteboard mounted in the centre of the front wall. Rather than having desks in rows facing the front, the classroom had identifiable learning spaces for independent, partner, large group, and teacher assisted learning. In addition, there was a computer centre with two work stations. The students' desks faced their learning partners in two long rows with no one's back to the interactive whiteboard at the front or to the whiteboard at the back of the room. A large open floor space located to the right of the interactive whiteboard was headed by an overstuffed old chair. Beside it was a teacher's easel with chart paper. Sarah's desk was in the back right corner and was piled high with books and paper.

School Two

Alex (pseudonym) was in his sixth year of teaching. He taught Grade 7 mathematics/science, the interdisciplinary project (The Canada Project), outdoor education, and forestry. He collaborated with a grade team of four other teachers. All of the grade team teachers participated in The iPad Project. No other teachers in the school had iPads. The team's work with students was guided by an overarching inquiry question: *How does our understanding of past interactions influence our decisions now and in the future*? The team managed the iPads together. Alex usually had six iPads in his room.

The observation period was for the month of April, 2011, Monday to Thursday with an additional visit in May. I was most often in Alex's classroom, but occasionally in the other Grade 7 rooms and the learning commons (library). During this time, I observed scheduled activities such as attendance-taking, lunch, mathematics/science, forestry option, student presentations, and The Canada Project. The Canada Project was designed to be a real life role playing game similar the video game Civilization® (Meier, 2010). In The Canada Project, students took on roles and became the architects of Canada's development over the course of a simulated 250 years and in the role of cartographers, literally redrew the map. Each classroom represented five different regions of Canada. Each week the teachers gave the students a new historical obstacle such as the war of 1812, Confederation and World War I. In each of the five classroom students were organized into roles. They then collaborated in their roles to deal with each situation. During mathematics and science periods I observed several problem-based activities. As with Sarah, Alex also used D2L. He posted student grades for mathematics and science in D2L. He also created a special D2L shell to support the Canada Project. I was added to observe and support its use.

At first glance, Alex's classroom also had a conventional look. The room was designed to be a science room. It had two computer workstations for student use. At the front of the classroom was a long whiteboard. The right wall had a bulletin board, cupboards, and a sink. The left wall was a sliding door that divided a double classroom. The back wall had large windows. The teacher's desk was located at the back and was piled high with books and paper. Alex used a Liquid Crystal Display (LCD) with his teacher laptop to project onto a pull-down screen at the front of the room. He did not have an interactive whiteboard in his classroom. What gave this classroom its contemporary feel was Alex's informal presence, as the students moved comfortably within the space. The desks were clustered in groups, not in rows. Students moved the desks to suit their needs and freely posted student created documents on the walls and bulletin boards.

Themes

Three themes emerged from the analysis of the data: 1) a description of the constructivist architect role for teachers, 2) enablers, and 3) constraints for entertaining unfamiliar technology. Following Stake (1995) a graph was created to aid in looking for patterns, reappearance, and frequency of themes (Figure 3). Each of these themes is discussed in the following section in order of frequency.

Theme One: The Constructivist Architect Role for Teachers

When asked about his role as a teacher, Thomas explained, "We are designers, designing things to help kids learn in a variety of ways." In this role, all three teachers expressed the feeling that their function was not to deliver knowledge but to mentor, guide, and participate in social knowledge construction in their classroom. Although many conventional responsibilities of teaching were observed, the interview and observation data revealed many new and altered

responsibilities for these teachers. Theme One is a description of these inter-related responsibilities. The responsibilities are discussed in order of frequency of observation as follows: (1) personalized learning; (2) collaborative citizenship; (3) life-long learning; (4) multiple literacy; (5) technology as a partner in learning; and (6) critical thinking.

Personalized learning.

In the role of architect of learning, the task for teachers is to provide a student-centred approach to instruction. The most frequent responsibility discussed was personalized learning "with flexible timing and pacing through a range of learning environments" (Government of Alberta, 2010b, p. 14). In an attempt to foster a positive classroom climate, I observed Sarah and Alex developing personal relationships with their students. Both teachers took time to talk individually to their students about what was important to them. The two teachers designed activities that met the diverse learning needs in their students. Thomas also spoke of the importance for his students to have choices in real world activities and to share their discoveries with each other. From the interview and observation data the following attributes emerged regarding this teacher responsibility: to (a) honour student voice in how learning was approached and presented; (b) design active learning activities that had an element of real life; (c) provide opportunities for self-discovery; (d) organize flexible learning spaces; and (e) respond to multiple forms of feedback.

Student choice/voice.

The three teachers permitted choice in how, where, when, and what rate student work was completed. During the structured interview at School One, Sarah and Thomas described their classrooms as places that looked and sounded different from one day to the next. Sarah said, "There is a time and place for everything, learning is an evolution, depending on the needs at the

moment." Thomas added, "Different people work differently, in different environments, and they are successful in different ways."

When asked about the elements they were looking for in students' finished work, Sarah said, "That depends on what they have been asked to do; our students have a lot of choice in their work." During the observation period students made choices in how to approach and complete activities within options approved by the teacher. During The Community Project students explored civic structures to determine what they felt was needed based on their personal interests. Students chose between laptops and iPads to gather information about the needs of their community. One student loved football and felt his community needed an NFL stadium, while others explored structures such as libraries and community centres. Another student who found it difficult to copy from the board used his personal iPod to take agenda notes. The same student was free to listen to music through head phones to help him stay focused during independent writing times. During quiet reading all students had a choice about whether to read books from home, the library, the classroom collection, or to use personal devices such as iPod. As well students could select their own location within the room to read. Student voice also meant that students shared personal expertise of technology. When Sarah discovered a child reading comics on his personal iPod during quiet reading, she took advantage of the interactive whiteboard and the document camera and asked him to share how he used his iPod with the class. A document camera connects to an interactive whiteboard projecting a much larger image of whatever is placed under it.

At School Two, in The Canada Project, students were given a choice in their roles to play. They had choice in what tools they used to act out these roles and choice in where they completed their tasks. During one presentation, students had a choice in how to answer teacher-

directed questions about World War I. While most students chose to stand and deliver their work, two different student groups shared videos they had created. Making videos was not directly taught but was modeled by the Grade 7 teachers. Alex said that he was disappointed that more students did not follow his lead and use the available technology creatively. He told me his plan was to make this experience an opportunity to dialogue about what makes engaging presentations and then have his student self-assess. He also told me how the discussion feature in D2L became a vehicle for student voice as quiet students also had a voice in decisions within the project. Alex said,

> When we have a discussion in class you get the same 10% that always speak and the 90% that never do…. Class opinion seems to always be swayed by whoever is talking…. Some of the students that participated in D2L were ones that never spoke in class…. I got to learn things from the quiet ones that I never would have in class.

I also observed two students asking to complete science assignments at home. They wanted to use technology only available there to complete the assignments in a special way.

Active learning.

The observation data suggested that Sarah and Alex designed active experiential learning activities with authentic, real problems with real world objects. At School One during a week-long mathematics inquiry on budgeting, the students worked with partners to build menu plans for a week. Given a set budget they looked through food flyers from the local supermarket. They cut out pictures to represent their choices and added the costs together. In The Community Project, students were able to use the city's actual civic interactive map and Google Earth, giving their communities a real world feel.

At School Two, The Canada Project was characterized by hands-on involvement, movement, talking and discussion, individual and small group work by students. Alex said it was designed to have a role-playing video game feel. Over the days and weeks of observation, the students worked in five different classrooms, the break-out rooms, and the learning commons. The various role groups documented their progress by posting their work on the walls and shelves throughout the classroom. They slowly transformed the room into a new Canada. The Scientists of the project posted a growing list of inventions, the Media group posted ever increasing realistic looking newspapers, Economists filled the whiteboard with equations, Historians added to their timeline, while Cartographers added cities and towns to their map. The students discussed strategy in large and small groups, and participated in online discussions in D2L.

Self-discovery.

In addition to active learning, Sarah and Alex designed problem-solving activities with an element of self-discovery. Learning tasks followed a learn-by-doing process that meant the outcome was not predictable, instructions were brief, and students worked using a discovery learning focus. Sarah and Alex waited for questions or signs of confusion before re-directing. Sarah said, "I prefer to have them lead to see where it goes." During a different mathematics inquiry, Sarah wanted her students to develop a strategy to figure out how much it would cost to cover their floor with a new rug. Again, with their learning partners, the task was to develop a strategy to solve the problem and then defend their strategy to another peer group. The goal was to develop a strategy that made sense, not just to find the right answer and be done. If it made sense to their peers, then they could present their strategy to me or Sarah to be video recorded. The final video would then be presented to their parents at the upcoming student-led, parent-

teacher interviews. Sarah explained that the students had had a really hard time with this process in a prior activity. They just wanted to be right. Sarah's hope was that with practise and the emphasis being put on the strategy and not the right answer, they would learn to be better risk takers.

Alex did a very similar math activity with his students. He said he wanted his students to come to their learning in a "natural way." He wanted his students to engage in their learning where ever it took them. He said, "If they are not engaged, there is going to be very little learning that is going to be useful past the classroom."

Flexibility for learning.

Sarah and Alex organized and took advantage of flexible spaces in their schools to honour their students' unique interests and learning preferences. They differentiated expectations to allow for differences in abilities. Sarah and Alex gave their students choices in who to work with and where to work. School One had created flexible learning spaces with tables and chairs in hallways and under stairwells. Sarah's classroom also had many identifiable learning spaces suited for personal preferences. She felt her role was to help students build skills in order to be confident learners while learning what their individual strengths and differences were. On one occasion a student on an individual program plan blurted out, "Can I chew gum to help me shut up?" Sarah calmly responded, "Why yes you can. I just wish you wouldn't use those words." She felt she could not treat every student the same.

In contrast School Two was a new building with flexible learning spaces built in. There was a small windowed breakout room, and a sliding barn door between classrooms as well as collaborative seating in the learning commons. During work sessions during The Canada Project students could book time in these locations to work with their role group. At one point

during The Canada Project students even taped shut the sliding door between two classrooms, when they declared their borders to be closed. The Grade 7 teachers monitored their students' progress and engaged in probing conversations while the students worked in these flexible learning spaces. Flexibility is discussed further as a teacher capacity.

Multiple forms of feedback.

During observation Sarah and Alex monitored their students' progress as part of the instruction process. With this formative assessment strategy they received and provided multiple forms of feedback. This information allowed Sarah and Alex to be responsive to their students' learning needs. Most common was a personal verbal questioning exchange of information between teacher and student. This information involved self- and peer-assessment, debriefing, and rubrics. Debriefing was usually a group discussion about choices made and the meaning of the activity. At School One at the end of an activity Sarah gathered her students into a large group to debrief about what each of them had experienced. In a different situation, Sarah used the interactive whiteboard as a centre activity for her students. During this activity two students used the page recorder feature while they worked through assigned mathematics equations. The page recording feature recorded every step they took. In the replay students were able to check for accuracy. The centre approach freed Sarah to work with other students and to come back to replay and debrief with the individual students. Rubrics created during the observation period were teacher-directed. They are described in more detail under technology as a partner in learning.

At School Two the grade 7 teachers organized The Canada Project activities similar to Sarah's learning centre approach. When students worked independently, the grade 7 teachers were free to observe the proceedings briefly in each other's classrooms. I understood this to be

important feedback for when the teachers gathered together to devise the next historical obstacle. Students also engaged in peer-feedback during a forestry option presentation. During the presentation students used the school's document camera to enlarge their work. The ease of viewing and enhanced image seemed to add to the student dialogue. Further, during a quiz, the students peer-marked the short-answer questions while engaging in open dialogue about the answers. Alex said it became information the teachers used to grade their students and make adjustments for the next historical obstacle.

Collaborative citizenship.

In the role of architect of learning, the task for teachers is to design activities where students worked together to advance classroom community goals (Government of Alberta, 2010b, p. 11). From the interview and observation data, the following attributes emerged with regard to teacher responsibility: a) teachers designed collaborative activities and work spaces; and b) when appropriate, authority and leadership were shared between students and teachers in the classroom.

Collaborative activities.

At School One, students worked with learning partners for most activities. At School Two, regardless of the activity very few students worked alone. Alex felt strongly about collaboration. He said, "I never let them *not* collaborate." When asked what he thought his students needed to be good at, he answered, "They need to learn how to work with other people and master unwritten social rules… It's huge." During The Canada Project students collaborated and the walls filled up with content from multiple contributors.

Shared authority.

The three teachers relinquished some of their conventional authority in the way they taught. In the interview Thomas said, "We strive for a democratic classroom where kids aren't being the helpless ones coming to teacher." He wanted his students to "live socially" and depend on each other for their learning. Similarly, in Sarah's classroom the students took their turn sitting in the teachers' over stuffed arm chair to lead activities and to deliver their own messages of learning. Sometimes as many as four students perched on the arms of the chair to work while the teacher worked elsewhere. Every day Sarah sat at the back of the room while each student took his or her turn to sit in the chair to perform the daily student-of-the-week duties. She said, "The biggest shift in education is that I'm not the one with the right answers." This speaks to the reworked role away from the teacher being the sole authority of knowledge in a classroom (Government of Alberta, 2010a).

At School Two, the whiteboard was not seen as an instructional tool used solely by the teacher, but as a teaching and learning tool shared by teacher and student. In one case, Alex asked permission from his students before erasing part of the whiteboard to demonstrate a mathematics concept. On a different occasion a student asked to come to the whiteboard to take over a lesson from Alex to share his expertise about a mathematics concept. Students were also allowed to use Alex's teacher laptop.

Life-long learning.

In the role of architect of learning, the teacher's task is to inspire in their students a strong sense of self and confidence to "act autonomously" (Government of Alberta, 2010b, p. 11). Sarah said, "I want these kids to have a passion for learning and to be able to--30 years down the road--to think, like me, oh I'm going to go get my Masters degree." From the data, the following

attributes emerged with regard to teacher responsibility: (a) manage a self-directed learning environment; (b) provide opportunities for student leadership; (c) hold students accountable for responsible choices; and (d) value self-assessment.

Self-direction.

Sarah and Alex created an environment for self-directed learning in which the objectives and strategies were discussed throughout the learning activities. Students were made aware of potential classroom resources, and it was clear that personal devices such as iPod were acceptable. As well, evaluation criteria such as rubrics were crafted with student participation. Sarah fostered a self-directed environment by writing a day plan on the whiteboard so her students could plan their day. They both organized a self-serve classroom with supplies and iPads in convenient locations. The three teachers reported seeing themselves as facilitators of the learning experience rather than as information providers. During observation when students did come to the Sarah and Alex for help in solving problems, they encouraged student independence. Sarah once replied, "That's an interesting problem. How are you going to solve it?" When a student asked Alex to solve a problem, without trivializing he said, "No!… I'm not going to tell you."

Student leadership.

Sarah and Alex provided opportunities for students to practice leadership skills. Once a week Sarah's students mentored reading buddies (Grades 1-2) and every day the student-of-the-week had a different leadership task. At School Two, during The Canada Project, one of the roles was leadership. At the start of the project the Grade 7 teachers presented various leadership styles in the learning commons. Later the leadership-role students in each of the five regions selected one on behalf of their region. Sarah and Alex encouraged student participation in

decision making. During one of the work sessions a student was playing a game app instead of attending to his role. While he was playing, another student took a leadership role and quietly took his iPad, deleted the app, and confidently returned it to him. She felt it was distracting him from focusing on the group's task. The game-playing student accepted her intervention with a shrug of his shoulders and returned to work. Student leadership gave students a sense of belonging.

Responsible choices.

Sarah and Alex nurtured student responsibility. I observed the teachers' usual playful manner swiftly shift to a no nonsense approach when it was required. Sarah and Alex took students who were making irresponsible choices aside without humiliation to suggest strategies on how they could work differently. At School One, I observed two class discussions on respect, one about global citizenship and one about wise choices when choosing partners. At School Two, students took responsibility for writing their own job descriptions in The Canada Project. Students, in turn, took responsibility for updating and displaying project documentation for each role group to see. Students also took a share in the responsibility of managing the charging of iPads which gave them a sense of ownership.

Self-assessment.

Sarah and Alex gained feedback on student progress with a range of assessment tools that included the students' perspectives. In her reporting to parents Sarah included student self-assessment. On two occasions the students used graphic organizers to learn about self-assessment. Further the students once worked through a role-playing exercise to help them prepare for the student-led interviews with their parents. At School Two, Alex told me the

students would self-assess after their role presentations to reflect on how well they made their presentations look and feel important.

Multiple literacies.

In the role of architect of learning, the task for teachers is to provide their students with opportunities to read and to express themselves in a variety of contexts including "current and emerging information and communication technologies" (Government of Alberta, 2010b, p. 11). In classroom observations, students worked with text as well as with images and digital media. Sarah and Alex gave their students opportunities to work through problems in a visual journal. The visual journal was used in a cross-curricular manner but accessed most often for solving mathematics inquiries. The students used the visual journals for art but also to draw diagrams, make charts, and mind map emerging ideas.

Sarah's and Thomas's professional learning community (PLC) explored the value of technology to support literary expression. In the classroom, Sarah encouraged her students to make personal choices for story planning and story telling supported by a collection of graphic organizers, visual journals, and multimedia tools (e.g., Comic Life, iPhoto, Keynote). Students sampled different tools of expression and worked in a variety of group situations as directed by the teacher. Students used iPads with apps such as Garageband, Doodle Buddy, Toontastic, and Comic Strip to explore literary expression and to develop and produce digital stories.

At School Two, Alex created digital content with his colleagues to present new historical obstacles in The Canada Project. During the presentation that I observed, some students had made movies, Power Points, and image slideshows to represent their understanding. In other situations I observed students working through mathematics problems in their visual journals. The three teachers not only wanted their students to access various forms of information but also

to be creators of and critical thinkers about information by engaging with various forms of communication.

Technology as an intellectual partner.

In the role of architect of learning, another teacher responsibility is to allow technology to function as a "partner in learning" (Howland et al., 2012, p. 7). From the interview and observation data the following attributes emerged: (a) technology was used to cultivate creative thinking and action, (b) technology supported assessment, (c) technology was accessed to support the process of knowledge construction, and (d) a variety of technological resources were accessible for students to choose from.

Cultivate creative thinking and action.

Sarah and Alex used technology to spark creative action. Sarah projected storybook video from an online collection of animated talking picture books for students to see. Instead of allowing students to be passive listeners, she used the experience to cultivate learning about story elements. She was able to stop the story at various points when she wanted to highlight a literary device or make connections to other stories. This activity sparked dialogue. Further she collected student-generated ideas on chart paper. The students were able to use these ideas to create their own story plans with their learning partners.

At School Two, Alex did something similar with science videos. He presented a science concept with a YouTube video. The students' task was to write a hypothesis of what they saw. The students were free to talk to each other and ask questions. Alex guided the students by stopping and starting the video while narrating using the vocabulary he wanted them to use in their writing.

Assessment.

Sarah and Alex used technology to balance performance assessment for grading. Sarah used her iPad to record her students during a benchmark reading assessment. She was able to observe her students using reading strategies during the test and revisited the recording to test for accuracy. This method, she reported, gave her richer and more meaningful data about *how* her students were learning to read, as well as valuable feedback with which to support them. Alex used the grading feature in D2L to manage, track, and report student progress. This tool helped him to understand which students needed more support and also to provide feedback not just to the students but also to their parents well before the end of a reporting period.

Knowledge construction.

Sarah and Alex used technology to support the construction of personal and community understanding. During the community structure project, Sarah used a Word document projected on the interactive whiteboard to capture brainstormed ideas about the finished presentation. With the help of her students, she then turned these collected ideas into a rubric to guide the completion of the student project.

At School Two, Alex used D2L as controllable space for knowledge construction. Alex found that by posing questions in the online discussion forum of D2L, he could easily monitor and track the conversation. The asynchronous nature of the conversation made it possible for his students to have the opportunity to think and then speak, thus giving the students a different level of participation than was possible in the face-to-face classroom. He also uploaded The Canada Project videos (historical obstacles) in D2L which allowed students to revisit the video when needed in order to work through problems.

Access.

Sarah and Alex allowed students to access a variety of conveniently located technology. This resulted in students using iPads, laptops, classroom computers, interactive whiteboards, a document camera, and personal iPods in both classrooms. Sarah said her students "need to be able to walk into a situation and just adapt to it." She felt what would make them successful was an ability to think critically about an appropriate piece of technology to efficiently support their needs. Sarah explained,

> It's not about the invention as much as it's about its use. There is a part of innovation that is about the quality of the invention but what is most important in innovation is how it is used in the classroom.

She felt it was important to plan opportunities for students to interact with technology in personal ways, "to learn what works and what doesn't from the experience, so they can discover what is best for them based on need." Sarah said,

> When students start thinking with the innovation and have experience with different kinds of technology then they have a power from that choice, it becomes a big thing…. It is not about choosing the right tool for the job; it is more about exploring the right tool for you in your personal situation.

Critical thinking.

In the role of architect of learning, the task for teachers is to create the conditions for students to "critically analyze and synthesize information" (Government of Alberta, 2010b, p. 10). From the interview and observation data, it became clear that the conditions included opportunities for students to: (a) think deeply, make connections, identify patterns, and solve problems; (b) judge for themselves how to navigate information from digital and face-to-face sources; and (c) have the freedom to make mistakes and reflect on their choices.

Think deeply.

In a large group situation, Sarah used a questioning strategy to help her students dig deeper to generate a collection of story element ideas. When reading stories, she used probing questions to help expand understandings. She did not accept passive listening. Gently she said, "I'm going to pick on you." During a reading of the story *Zero* (Otoshi, 2010), she stopped to point out connections to prior classroom experiences. "What do you see? What don't you see?" At the end she asked, "What was the story about?" While validating the initial comments, she then tried to pull more information and ideas out of the students by using questions such as: "What are some other thoughts?…What does it make you think of?" She read a second book by the same author. In wanting them to recognize a pattern Sarah said, "We should compare." For making connections between the character and their own life, she had them reflect in their journals. Sarah asked, "What would you say to Zero to make her feel that she counted?" Days later she re-visited the same book with a second task. Sarah asked, "Can you write a similar story about yourself?"

At the beginning of The Canada Project students at School Two brainstormed about the values their regions would hold. Weeks later Alex wanted the students to connect to that experience. "Consider the value of the technologies you invent. How well [do they] fit the values of your region?" Later when speaking to the students in the economist role, Alex wanted them to make connections between subjects. Alex said, "Do you remember in mathematics we talked about being able to show statistics in a meaningful way?" On another occasion he made connections to real world happenings. Alex told them, "You need to make sure your people are working; if you have a farm and no one is working then it is not productive." On another

occasion during a forestry class, Alex told his students he wanted them to make connections to what was happening in The Canada Project.

Judgement.

As described in the Personalized Learning section, the interview and observation data suggested that the three teachers valued student choice. Students judged for themselves what tools to use. Thomas spoke about how he felt the world was changing and teaching was also. He said, "Teachers can't separate what they teach from the world." He felt that learning for his students was not about gaining knowledge. "What I want to do is give them the tools to think critically, navigate, judge, and live well in the world." Alex on the other hand said he wanted his students to make up their own minds in their choice of technology but expressed concern that "a lot of times they don't like going outside their comfort zone." Occasionally he encouraged the students to try something new.

Reflection and the value of failure.

Thomas told me that they structured formal time after activities for students to reflect on their technology choices. "Did this tool work for you?…Why did it?…What might be better next time?" Thomas said he wanted them to "experience and make a choice for themselves." At School Two, Alex used a more informal method to reflect on how well students effectively used technology. Alex said, "I wait for the students to come to me." Alex said he knew an experience was effective "when they come to me all excited, Look at this, look at this!" When I asked him if the students had a definition of technology to work within The Canada Project, Alex said he did not, "I want them to grapple with that when it makes sense to them." This reflection was meant to help the students recognize strengths and weaknesses in their reasoning.

Theme Two: Enablers

The *architect* role reflects the notion that, "technology makes things possible, people make things happen" (Government of Alberta, 2010b, p. 23). In the role of architect of learning, the task for teachers is to provide enriched learning experiences in a responsive environment where the learning need drives the use and choice of technology. This role also incorporates the idea that if the changing nature of technology is to be beneficial, new and emerging (unfamiliar) technologies will have to be explored.

The three teachers each reported a confidence and a willingness to try many technologies, not just the iPad. In seeking to find out how they made sense of this unfamiliar technology it was important not to isolate the use of iPads from other technology used in the classroom. Ketelaar et al. (2012) in their study reported that teachers made sense of educational innovation in light of their knowledge, beliefs and experience and also their situational demands. It was also important to explore the entire context of the teaching and learning environment and not just the classroom where technology was used. Theme two considers a framework of three enablers for teachers to make sense of *unfamiliar* technology. In order of frequency of observation they were: (1) teacher capacity; (2) affordances from the school environment; and (3) affordances from the school district.

Teacher capacity.

The first enabler for the three teachers to make sense of unfamiliar technology highlighted an internal affordance, a capacity belonging to the teachers. Capacity was identified as a personal capability or power to act. From the data the following attributes emerged with regard to teacher capacity: (a) a commitment to life-long learning; (b) skills, knowledge,

experience, and belief in the value of technology; (c) a flexibility towards diversity and change; and d) a collaborative spirit.

Commitment to life-long learning.

The most frequent enabler observed by far was the teachers' commitment to life-long learning and a playful and curious disposition. All three teachers told me they wanted to participate in The iPad Project so that they could have iPads. They also willingly participated in professional development provided by The iPad Project which was over and above that done by the other teachers in their schools. At different times they described their participation in the project as fun. Alex said, "learning is exciting for us." The three also reported taking personal time to explore technology to make sense of its place in their classroom. Thomas described what he did as, "tinkering with technology." Thomas said, "We will do it on our own because we enjoy it."

Sarah described an experience with her evaluation two years earlier that showed her level of commitment to learning. Sarah said, "the new shift in the evaluation process is just evaluation, no mentoring." She questioned the lack of feedback during her evaluation, "I kept pulling for it." With a proud smile Sarah said, "eventually, I got it." Further she talked about her father (also a teacher), "he has a love of gadgets and Apple technology. He's an innovator so I guess that's where I get it from." Sarah added that teachers can learn from their students. "Your kids may know more than you and that's a good thing." Her learning also had a formal component in that she planned to pursue her Masters degree in educational technology.

Alex showed a playful side when he used his iPhone to time the students during roll call. If they could do the attendance in less than an agreed upon time, they would get a point towards a pizza party. Later he chuckled with pride as he showed me his dinosaur lunch box. He had

bought it at the zoo during one of The iPad Project professional development days. Alex said, "I like thinking outside the box, I think that helps." I added, "you seem to have an ability to play." He answered, "yes, I like to try new things and not keep doing the same old thing over again; that is boring."

Valued technology as a learning tool.

As was expressed under the first theme of teacher role and responsibilities, the three teachers treated technology as a partner in the teaching and learning process. When asked about evaluating a particular technology's impact on learning, Sarah replied, "I am looking for a process. I want to see how the group is engaged, are they doing purposeful work and if not, then that's not the piece of technology they should be using." Alex said he wanted technology "to allow the kids to expand their creativity."

Teacher skill and experience with technology were the least observed attribute of teacher capacity. Sarah and Alex brought a level of skill with technology and enough teaching experience (five and six years) to feel comfortable. Sarah had had several jobs with technology before considering the teaching profession. She also took two online professional development classes in D2L. Sarah reported that in her school, she was the one giving the technology professional development. Teachers in her school could sign up for tech PD sessions with her after school. Alex felt very comfortable with technology and received informal learning support from his peer group and, on request, from an Alberta Initiative for School Improvement (AISI) learning leader (Government of Alberta, 2011). Neither Sarah nor Alex highlighted their technology skill to their students. Even though it would have been easier for them to solve the students' technology issues, they insisted that the students consult each other to find solutions.

Flexibility towards diversity.

On several occasions Sarah and Alex adjusted their plans to meet the diverse needs of their students. Sarah and I discussed flexibility in the learning environment in terms of a metaphor of a sandbox: a playful place but one with edges. Sarah agreed with this metaphor but added, "I like a well-managed classroom… it's kind of like organized chaos." Not all of her students came to school with the same level of independence. In her classroom, I twice observed students working using a learning centre approach. In this situation self-directed students supported others. In addition she took advantage of school assistants and volunteers including myself to support struggling students. She adjusted many things on the fly. She said, "It's about juggling and making it work. I try to be consistent but you have to be flexible."

Not all students completed work at the same time. I witnessed Sarah's use of a flexible timetable called Work on Work time (WOW). She gave students the opportunity to make personal choices to work on what they felt was a priority, based on the collection of assignments due. I observed students working on as many as four different activities at a time. During these times, Sarah was available to support the less independent students. On two occasions, Sarah made adjustments when schedules were unexpectedly changed, once when the network was down and once when someone else was using the desired laptops. On both of these occasions she sought feedback from her students before writing a new plan.

Alex adopted a flexible schedule and flexible groupings to allow students to make choices in terms of where they worked and who they worked with. The Canada Project was responsive to student participation while giving the Grade 7 teachers just enough power to deliver what he called "a curve ball once in a while." The goal was to engage the students while guiding them through specific curriculum outcomes.

Collaborative spirit.

All the teachers in both schools participated in small collaborative team groupings called a Professional Learning Community (PLC). Sarah said she fed off brainstorming with other teachers: "I think it's interesting to see other peoples' practice. The best years are having a good team to work with, someone to bounce ideas off." When I asked, are you able to personalize your PLC learning? Sarah replied, "Yes… because we are a small group we can focus on the needs of our students. I would say we are pretty much able to personalize pretty much whatever we want…. We make it work for us." In addition to the PLC, I was able to see how Sarah and Thomas supported each other throughout the day by bouncing ideas off each other. I observed similar collaboration with Alex as many times the Grade 7 teachers during The Canada Project and during their lunch hours popped into each others' classrooms to ask 'how to' questions, share observations, and check on student progress.

Affordances at the school.

The teachers' sense-making of the iPad did not occur in isolation. A second enabler for the three teachers to make sense of unfamiliar technology was found in the school culture. When considering sense-making, contextual factors included the school culture as a whole. I was curious to see what sorts of conditions facilitated the teachers' capacity to try out new things. The school culture was concerned with shared beliefs and ways of working. The three teachers worked within a school-wide pedagogy of meaningful learning *with* technology (Howland et al., 2012). School affordances that I observed had the following attributes: (a) professional learning opportunities within a reflective collaborative culture; and (b) administrative allowances for flexibility.

Collaborative culture.

There was a structure in place in both schools to support a collaborative culture. Ketelaar et al. (2012) reported that collaboration can lead to more information and better knowledge for teachers which strengthens their feelings of ownership. All of the teachers were assigned to small grade group teams and given time during their contractual day to work interdependently to achieve common goals for their students. The focus of the meetings observed was not on how to collaborate but on how the team could support individual student's needs. At Sarah's school, I was told they had created an overarching curriculum goal of story writing. Sarah's PLC included Thomas and one other literacy teacher. I observed Sarah and Thomas' PLC take turns presenting their students stories while the others offered insights into what was the evidence of learning and what were the next steps to support the student. Sarah and Thomas also talked about which apps on the iPad might be explored to support their students' writing. During the PLC meeting, the two of them expressed a desire that they wanted to be clear about what they wanted their students to learn, how they would recognize success, the next steps for each student and how they might extend or enrich the experience for those who demonstrated a high level of success.

Alex's PLC included the four other Grade 7 teachers. I did not attend their PLC meetings but I was told that as a grade team they had created an overarching curriculum goal that fed into The Canada Project. I did, however, observe two planning sessions about The Canada Project. The Grade 7 teachers brainstormed what might be the next historical obstacle and how best to present it to the students to achieve engagement in the activity. I was told they had formal PLC meetings similar to Sarah's and Thomas's after school hours. Almost every day during The Canada Project the sliding door between the two Grade 7 rooms was rolled open. This allowed

the two teachers to support each other when needed and to check with each other on student progress

Administrative flexibility.

Inspiring Action (Government of Alberta, 2010a) has suggested that in order for education to be responsive to diverse learning needs, schools need to be more flexible. Sarah explained how her school administration used flexible time with 0.4 teacher time to create what they called a learning commons role. In this role Sarah supported collaborative learning projects of her peers in various classrooms through the year. I did not meet with the administration, but I did observe Sarah in this role twice. During this time, a literacy teacher came in to support her class while she and three other teachers used a learning centre approach in an open concept double classroom. Instead of two teachers in two classrooms, the students now had four teachers to support their inquiry work. The teachers utilized two interactive whiteboards, four classroom computers, and a laptop cart. The two classroom teachers led the activity while Sarah supported students on their laptops. I was also told that Sarah planned with the group of teachers prior to each project and met once a week during the project to collaborate and provide ongoing support. I understood she worked through a collaborative process, as an extra set of hands and shared her technological expertise as a way for the other teachers to experience technology applications within an authentic context. While the iPads remained behind in the classroom, this spoke to the school culture for meaningful learning with technology in general.

Sarah also told me she felt supported by her current principal who had a background in technology with a Masters degree in educational technology. Sarah thought this background made it easier for her to ask for what she needed: "I spend less time explaining why I need a digital camera, she just knows." She did not imply that there were more funds for her than others.

It was also reported that, in each school, the principal's efforts were instrumental in these schools being accepted for the iPad Project.

At School Two, similar to School One, a flexible schedule was also employed to allow for The Canada Project to occur. They did not have an additional 0.4 flexible time in place to support the project; however the Grade 7 team used a double period every day to work on The Canada Project over the entire semester. On one occasion I observed the Grade 7 teachers shorten a mathematics period to provide additional time for the project. Alex reported that he did not feel he had to ask his principal for every adjustment made; he felt supported by his principal for the project.

In the two schools, the three teachers had ample technology resources, a focus on meaningful learning with technology, opportunities to collaborate, opportunities to develop technology skills within authentic contexts and to discuss problems with peers and a supportive administration. Ertmer and Ottenbreit-Leftwich (2012) reported that these conditions create an agreeable climate for teachers who are trying to adopt pedagogical innovations [unfamiliar technology] (p. 5).

Affordances from the school district.

A third enabler for the three teachers to make sense of unfamiliar technology came from the school district which provided the following support: (a) IT technicians who kept software up-to-date, (b) IT supplying a variety of supported technology, and (c) the school district supplying teacher learning support.

IT support.

I was told that all teaching staff throughout the district had laptops maintained by the IT staff who managed all updates and software installations. Each school kept a binder in which

staff reported technical issues and problems. At School One, I saw the IT support person twice. Sarah told me he came once a week. In addition teachers had access to a help desk that they could call during non-instructional times to ask for help with their computers (not iPads). Sarah and Thomas stated that teachers needed to feel confident that the technology would work for them when they needed it.

Variety of technology.

Sarah said, "In our schools we have so much technology." School One had two roaming laptop carts. The upstairs cart had 24 laptops; the one downstairs had 17 laptops. Each classroom had two computer desktop workstations, each teacher had a laptop and each classroom had a mounted interactive whiteboard. The learning commons also had an interactive whiteboard and a mini-lab of eight desktop workstations. Sarah used her interactive whiteboard and classroom computers every day. The students used the iPads most days, the laptops from the cart half the time, and a document camera twice during the observation period.

At School Two in the learning commons, there were 25 desktop computers and multiple laptop carts with 15 laptops in each. There was also an interactive whiteboard that Alex used three times during the research observation period. Each classroom had two computer workstations. Each teacher had a laptop. Alex used his laptop and LCD projector every day. His students used a document camera twice, while laptops, classroom computers, and iPads were used every day during the observation period. The three teachers wanted to facilitate personalization by providing a variety of technology for students to share in the responsibility of choice making.

Learning support.

At School One Sarah had taken two e-PD courses offered by the school district geared toward pedagogical use of D2L. Thomas had attended workshops. At School Two Alex shared information about an AISI Learning Leader who was available upon request to support his learning with D2L. This access to diverse learning opportunities and support allowed the three teachers to expand their understanding of technology specifically to meet their needs.

Theme Three: Constraints

Cuban (2001) reported that simply putting new technology in the classroom did not automatically lead to meaningful use. Jonassen's (1994) view of technology as a cognitive tool encouraged teachers to create learning activities that put technology into the hands of students to facilitate their work. The three teachers demonstrated an interest in this sort of pedagogy. However, in the study my concern for understanding included identifying possible constraints that impacted teachers' efforts to make sense of unfamiliar technology. Since contextual elements included a framework of enablers, a broad range of activities were observed.

Again in an effort to develop experiential understanding of how teachers made sense of the iPad in the context of teaching and learning, it was important to look broadly at day-to-day activities. While exploring tensions in the classroom a third theme emerged considered to be constraints. In a framework of enablers constraints are not considered to be the opposite of enablers. A tea pot metaphor is helpful to understand the relationship between enablers and constraints. The handle affords pouring while the spout hopefully constrains the flow into the cup. The interview and observational data suggested that these teachers were busy and making sense of unfamiliar technology required that they spend extra effort and personal time to do so. Schrum et al. (2008) reported that tech-savvy teacher were willing to sacrifice personal time and

money. I wondered how day-to-day tensions might impact their willingness to be open to new things. The three teachers in the study seemed to take these tensions or constraints in their stride. They are discussed in order of frequency of observation as follows: (1) limitations of time; (2) infrastructure for technology use; (3) prescribed professional learning; and (4) a remnant of a conventional role of teacher authority.

Limitation of time.

The limitation of time was characterized in the study as those tasks that required increased consideration over and above normal classroom attention and preparation. At School One the teachers had 30 minutes preparation time four times per week while at School Two the teachers had 55 minutes four times per week. Both schools had Friday afternoons for staff meetings and school professional development. School One (elementary) had more observable limitations of time than School Two (junior high). From the data the following attributes emerged with regard to limitations of time: (a) administrative or assessment tasks; (b) meetings, clubs, and supervision; and (c) teacher evaluation.

Administrative tasks.

I had the opportunity to attend one field trip with School One. A field trip meant filling out paperwork, and managing consent forms and money. I observed Sarah managing this task during her teaching day when her students took leadership roles and when they were working independently. A teacher was also required to make a personal trip to the site prior to the class visit. Alex expressed concern when he reported that new field trip forms required additional professional development time to learn how to complete them.

As well, the new iPad technology appeared to attract external attention. In addition to the attention Sarah gave to the study, a newspaper reporter visited Sarah for a story on how she was

using the iPads. This meant that she had to fill out special media release forms for her students, have a lunchtime meeting with the principal, and spend time in the evening planning for possible questions. She was also willing to spend her evening planning the use of the iPads during his visit. Teachers in The iPad Project were required to administer the iPads in their own time. Sarah and Alex said they usually took the iPads home to update them during personal time. Sarah also reported that while she enjoyed her learning commons role, it gave her more duties, more meetings, more preparation work, and did not give her an extra administrative salary. She also spoke of her willingness to spend personal time creating a video for parents about the learning commons role. These additional responsibilities required additional time that did not fit into a normal work day.

Meeting time.

Thomas said, "our school is meeting heavy." The teachers at School One met for PLC meetings, team meetings for projects, staff meetings, and professional development meetings, each once a week. They met occasionally for committee meetings and to supervise clubs. Sarah said she usually had one lunch hour a week for herself. Once I observed her give up her lunchtime to supervise her students during a fun lunch and once to help cater lunch for her staff on a special event. On more than one occasion I noticed Sarah and Alex finishing their lunch during afternoon class time. In addition, all teachers in the iPad Project met once a month after school in addition to the time their peers spent.

Teacher supervision and evaluation.

While Thomas agreed to the structured interview and informal conversations, he declined my research presence in his classroom. Thomas was new to teaching and on a temporary contract. On three occasions he spoke about the burden of evaluation. Evaluation was a formal

process of gathering evidence over time; it meant that six times during the school year the principal came for classroom observation. Thomas was required to follow each visit with a written reflection. Thomas explained to me that evaluation was not a mentoring process. Thomas said, "I just feel a large amount of stress." He indicated that the thought of participant observation on top of his evaluation and participation in The iPad Project was just too much.

The teachers in The iPad Project had to shift their teaching roles to include managing the content and syncing apps within their school's iTunes account. This process required a considerable amount of teacher time on top of their day-to-day tasks (Crichton et al., 2012).

Infrastructure.

Since the purpose of The iPad Project was to gain an understanding of the infrastructure required to support handheld devices in classrooms, teachers in the project were breaking new territory. Given this new territory, the iPad users did experience many constraints. From the data, the following attributes emerged with regard to inhibiting infrastructure: (a) Internet filters and network connectivity; and (b) lack of computer administrator privileges.

Internet filters.

The most common frustration reported by the three teachers was Internet filtering and the connectivity with the network. All mobile devices including the iPads were required to log on to the school's Learner Accessible Wireless Network (LAWN). On this network users had no access to printing, email, and YouTube with no opportunity to override (as with other school-owned devices). In addition D2L did not recognize the iPad and the dropbox feature was not accessible. This meant that students could not watch the video content created by their teachers or hand in completed assignments using the drop box; instead they had to hand in the iPad. One student at School Two retyped two days of work onto a computer when she realized this. In

addition, Internet and network connection occasionally dropped when using the iPad, initially causing confusion for users.

Lack of computer administration privileges.

All teachers were given one-to-one teacher laptops but they were not given administrative privileges. This meant they had to wait to update software and to submit a request to download new software. This was more of an issue for the teachers at School Two where the Grade 7 teachers wanted to create digital content to support The Canada Project. One of the Grade 7 teachers told me he purchased his own MacBook Pro™ in order to avoid this issue. At School One I observed other teachers come to Sarah for help with their teacher laptops. On two occasions she explained that she could not help as she did not have administrator privileges. I was told that these teachers had to wait the week for the IT support person to come to the school and address the problem.

The iPad Project removed some of these constraints. The teachers in the Project were given some administrative privileges on the iPads that were not given to teachers in general on computers. An iTunes account was created for each of the schools in The iPad Project on one lap top. This allowed teachers in The iPad Project to purchase apps that they could then independently synchronize when they wanted to without IT support. Sarah was the teacher in her school to perform the updating task and all of the teachers in Alex's school took turns. This gave the three teachers more independence in terms of updates and app selection than was the case for their laptop use. The iTunes account was linked to the school's email address. This avoided the three teachers having to use their personal accounts. The secretary in each school could then manage the budget (Crichton et al., 2012).

Teacher learning.

Many teachers in the past learned to teach by watching the teachers who taught them (Hargreaves, 2003, p. 24). The role of architect of learning requires a teacher to learn to teach in ways that they were not taught as students. The three teachers were willing to learn but reported feeling constrained with: (a) limited personalization for teacher learning; (b) limited time to explore unfamiliar technology; and (c) a concern for the tone of change.

Personalization for teacher learning.

Both schools had the structure in place to support a professional learning community (PLC). At School One, I had an opportunity to attend two PLC meetings. While these meetings were collaborative, they did not focus on teacher learning. They followed an agenda called a protocol that was set by the administration. During this meeting Thomas shared student writing examples. Within minutes the group began to talk about how to fill out the form. Thomas confessed he did not like the protocol. When asked how much choice he had in his PLC Thomas said, "we have a choice of four different protocols." He could not name all of them. "I find our group is generally on topic most of the time and we don't really need much steering; in the end I find the protocol more of a distraction, we spend our time talking about how to fill this thing out rather than on the work." The concern was that too much focus on the protocol distracted them from building on what they perceived to be the students' learning needs. Sarah on the other hand felt happy with the amount of personalization.

The iPad Project learning did not burden Alex. He said, "when you are interested, it doesn't seem like work." Alex expressed his enjoyment for the learning he participated in during The iPad Project. School Two had a structure in place to support professional learning. However when I asked Alex if he *owned* his own learning at his school, Alex replied quickly with "NO! I

shut down in a lot of those meetings. The way they are structured is a lot like the way teachers used to teach: sit, talk, and listen. So much of our learning is delivered in the traditional way." Alex felt that most of what was presented for professional development was not practical and was disconnected with the process of real learning. Alex described one professional day:

> I did what I tell my kids to do when they are feeling disengaged, I told my principal this is not going to be beneficial for me. I would find it more beneficial if I sat down with a co-worker and we sat down and did this…. I took control of my own learning, she was supportive, and she even gave us resources. I don't know how many times we would get away with it.

After six years of teaching, Alex felt he had the confidence to ask for something different. He felt the experience was more meaningful when he was able to take ownership of his learning.

Time to explore.

The three teachers said it was important for teachers in general to have time to explore the value of any new technology. Much like having a new student in an established classroom, unfamiliar technology takes time to fit in. The three teachers reported that The iPad Project treated them like learners. The three teachers also reported a different experience in their own schools with other technology. Sarah reported that she often found herself frustrated by not being able to spend much time outside of her learning commons role to support her colleagues in their learning with technology. In her learning commons role she could work collaboratively with other teachers to support student goals, but not teacher learning. Sarah felt learning with technology depended on teacher attitude. She felt if teachers saw themselves as risk takers they would have an easier time. However Sarah expressed concern in her school when teachers did receive professional development about new technology from the school district. "A lot of times

it's really quick and you do not get enough hands-on time to really learn it, you are listening rather than doing." She added, "teachers learn by doing and really need to see the purpose and have time to play and invest time in learning." The worry was that her colleges would not want to figure out the new technology in their free time or in front of their students. Sarah said she has run tech cafés after school but they do not seem to be working, "teachers are so busy."

Thomas reported that he did not mind spending his personal time to explore the value of technology. He felt he was an independent learner but because he was new to teaching everything seemed a little overwhelming. He said schools do not seem to want to devote PD time to helping teachers learn about technology. If he wanted to learn more, he would have to take a weekend class.

Alex also did not mind learning on his own time. He liked that he had an AISI learning leader available two times a week in his building to help him learn to use D2L; however he was also concerned with time to participate in his own learning. "We don't have a lot of time anymore. The world just keeps going faster and faster." For him most PD seemed to be disconnected to what he wanted to learn. Too often he felt that someone else was choosing what he was learning, making it difficult to take ownership.

Tone of change.

The three teachers did find ways of personalizing their learning with technology in their own time. Sarah and Thomas felt supported by their administration. They related that any frustration in using the iPad did not come from the device itself, but from the connectivity. Alex also said he felt supported by his administration; however, when describing his Professional Day experience, Alex felt constrained. He said it was not clear that he had the option to participate in his own learning. He felt he needed courage to ask for something different. Alex said, "I felt like

I was pushing the envelope." When talking further about the conditions for innovation in teaching practice, Alex responded, "climate is huge." He felt that school leaders "need to be able not to micro manage; they have to be able to give you the freedom." Alex talked about the importance of positive messages for change in teacher practice. He spoke about his concern about a recent video message from the school district that he felt delivered a harsh and some what scolding message for teachers. "It doesn't create a very good climate for working and it doesn't set a very good tone…. If you want innovative teaching, you have to allow for some freedom."

Knowledge authority.

The knowledge authority as described in Inspiring Education (Government of Alberta, 2010a) seems to place teachers in an instructionist role. Jonassen (1994) reported that instructionist teachers might use technology "as conveyors of information, communicators of knowledge, or tutors of students". This role was founded on the premise that communicating content to students would result in learning (para. 1). The three teachers in the study did not demonstrate these traits but traces of the concept of *knowledge authority* within the teaching and learning environment did provide a few constraining situations. The following attributes emerged: (a) a concept of teacher authority, memorization with rote drill, and practice; and (b) technology as an instrument to deliver content for knowledge acquisition.

Teacher authority.

Meaningful learning with technology requires that teachers relinquish some of their authority (Howland et al., 2012). The drill and practice strategy and the strong teacher authority role is generally believed to promote the acquisition of knowledge or skill through repetition (Cuban, 2001; Papert, 1993). Observational data suggested that conventional drill and practice

strategies associated with the instructionist role were not important to these three teachers. However, Sarah commented that most of the educational apps in the iTunes store were geared towards drill and practice. Further both she and Alex told me of parents who wanted their children to have drill and practice homework. Alex also relayed a story about parents who felt that the reason their son was misbehaving in his class was that the student was not challenged. With teachers as designers of learning, students have more responsibility in the learning of facts and skills. Alex felt that the parents wanted him and not their son to take responsibly for their child's learning.

Delivery tool.

When technology is used to support knowledge acquisition and deliver proof of learning, it can be seen as a delivery tool. Sarah and Thomas at School One used D2L to deliver their PLC notes to the administration. I was told there was no dialogue about the notes, nor did the teachers revisit them. It was a way to pass on the information. I looked for evidence of this in Sarah's and Alex's classrooms but did not see any. At first glance it appeared that when Sarah and Alex projected videos, they were using technology as a delivery tool. This judgement was later shifted to technology as a partner in learning, as described in the Theme One section. Observational data did not reveal that these teachers were merely using technology to deliver knowledge, but rather in each occurrence the technology was used to spark dialogue and action with the students.

Summary

Through analysis of the interview and observation data, three factors stood out. First, the role of *architect of learning* embodied a constructivist foundation. In this role the three teachers made sense of the iPad with their students as intellectual partners within a framework of enablers, and not by making the iPad the centre of their teaching. Second, teacher capacity was a

key enabler for making this possible. Third, while limitations of time, infrastructure, and affordances for teacher learning challenged the teachers to engage with unfamiliar technology, it was apparent that enablers had a more positive impact in facilitating the process of sense making than the constraints had on limiting it. In other words, for the teachers in the study, the constraints were not seen as barriers to making sense of unfamiliar technology. The discussion of these findings will be addressed in Chapter Five.

Chapter Five: Discussion Of Findings

In this chapter I provide a thoughtful discussion of the findings, along with answering each of the research questions. The first research question will be answered using a framework of internal and external enablers. Enablers were found to be: teacher capacity, an internal quality from the individual teachers; and external affordances, qualities from the environment such as what it offered, what it constrained, what it provided, and what it invited. The second research question will be answered as three lessons learned and presented as suggestions to facilitate the implementation of new and emerging technology. The chapter concludes with implications for school districts, school administrators, and teachers entertaining new and emerging technology. The implications highlight an interconnected responsibility that needs to be addressed.

Sense Making Of An Unfamiliar Technology

The first question guided the research: *How do teachers make sense of new and emerging technology to enhance teaching and learning?* While constraints such as time to explore unfamiliar technology, Internet filters, infrastructure, limited opportunities to support each other with technology and to personalize their learning were frustrating, the three teacher participants were more than willing to use unfamiliar technology. The observation and interview data in the two schools indicated that the three teachers made sense of unfamiliar technology within a constructivist environment that reinforced their beliefs about teaching and learning. This data as a whole also suggested that the principle of a constructivist teaching and learning environment supported the development of the teacher participants' capacity to use unfamiliar technology.

A Framework of enablers

Zhang and Patel (2006) have used a framework to describe and explain the concept of affordance. They described their work as stemming from Gibson's (1977) concept of affordance; action possibilities within the environment that are dependent on an individual's capabilities. As defined by Zhang and Patel (2006), affordances are distributed across the environment as interactions. both internal, what the individual perceives or brings, and external, what the environment provides or encourages. A distribution was evident in my study as interactions across the school district, school environments, teachers, and students which I have called a framework of enablers. The three teachers brought their individual capacity to use technology in their teaching; the school environment offered similar collaborative working conditions and professional learning opportunities; while the district provided a similar networked infrastructure, IT support, and enough technology to allow for teacher and student choice to support learning. Together the environment invited the three teachers to take ownership over their technology choices in the classroom and they were empowered to respond to constraints.

Teacher capacity.

The three teachers in this study each had an individual capacity to be open to the possibilities the iPad might present. The study revealed the following common elements of teacher capacity: commitment to life-long learning; technology valued as a learning tool; willingness to act; a collaborative spirit with peers; and flexibility towards diversity in their students' strengths and needs.

All three teachers chose to learn about the iPad with and in front of their students. In their classrooms, Sarah and Alex demonstrated a fun-loving attitude towards teaching and learning. The three teachers also reported believing technology supported their students in becoming life-

long learners. Sarah expressed a hope that her students would develop a love of learning. The three teachers talked about a kind of knowledge that recognized the pursuit of real life activities. Sarah and Alex in their classroom activities demonstrated a desire for students to make connections across the curriculum and in their own lives. Alex said that in The Canada Project his students were learning skills and making connections between mathematics and science. The observation data in the two classrooms indicated students actively constructed knowledge out of their experiences while Sarah and Alex encouraged students to connect their work to their personal interests and experience. Thomas expressed a desire for his students to think and to learn how to learn. These findings relate directly to the findings of Schrum et al. (2008) in that tech-savvy teachers wanted to inspire their students to engage, perform, and become life-long learners. Similar to the TPACK framework, the data also indicated that the three teachers were digital-age professionals with technological skills, pedagogical experience, and comfort with the day-to-day events in the classroom.

All three teachers expressed that learning came first and that they valued technology as a tool for learning. Thomas reported he felt that what was the most important thing for his students to learn was to live socially and to learn how to learn. He felt the world was changing and so the teaching role needed to change with it. Sarah felt that her role was to demonstrate how to learn and that using the iPad for this end helped her to be more a effective teacher. Alex felt that engagement was key, if his students were not personally engaged with their learning, then very little learning will be useful past the classroom. This fits with Alberta Education's (2012) finding that iPads made a positive difference in classrooms when they are used in pedagogically sound ways. Sarah and Thomas also reported a belief that providing their students with choice of technology leads to a deeper understanding of its power. Observational data indicated that both

Sarah and Alex gave their students choice. This notion of technology as a powerful tool to augment the process of learning ties into Duffy's and Cunningham's (1996) explanation of constructivism. The three teachers made sense of the iPad with their students, while not making the technology the focus of their teaching. The three teachers did not write lesson plans that featured the iPad or spend much time introducing the iPad to their students. The observational data suggested that Sarah and Alex valued the process of exploration in learning. Sarah and Thomas allowed their students to discover and integrate technology as an integral part of the learning process. This finding ties with Derry's (2008) learning-driven focus of technology-enhanced learning environments as well as with the concept of meaningful learning *with* technology (Howland et al., 2012). The technology was used in ways to support the process of teaching and learning.

The interview data indicated that the three teachers had a willingness to volunteer their personal time to explore the iPad's potential in support of their teaching. The three attended additional professional development and dealt with extra attention from researchers and Sarah from news media with regard to the use of iPads. The three teachers reported they spent a great deal of personal time learning via 'tinkering' with the technology. They went out of their way to get the iPads into their classrooms and performed extra work to manage them. However in the end, the three teachers said they left it to their students to grapple with the value of iPad technology for their learning needs. Schrum et al. (2008) described this as a characteristic of tech-savvy teachers. The three teachers' willingness to learn with technology, demonstrated through a significant investment of personal time, provided an insight into the capacity of these teachers to make sense of unfamiliar technology.

The observation data revealed that the three teachers had a collaborative spirit not just with their colleagues but also with their students. At both schools the teacher-participants negotiated the use of a technology's potential with their students. For example, Sarah encouraged her students to share in solving classroom road blocks. Being in side-by-side classrooms, Sarah and Thomas worked out how to share the collection of iPads with each other's students. Alex allowed his students to share his whiteboard and bulletin board space as well as his teacher laptop. From their findings Ketelaar et al. (2012) argued that a collaborative environment leads to a better understanding of innovation [unfamiliar technology], which in turn strengthens feelings of ownership. This collaborative spirit was evident in my study as the three teachers encouraged shared authority in many classroom activities, collaborative use of technology in the classroom, and collaboration with other teachers to support teaching and learning.

Sarah and Alex demonstrated flexibility and judgement. When tension arose, they quickly adjusted their lessons and strategies to accommodate the situation. They both used an array of instructional techniques and showed courage to change direction in front of their students when required. Sarah and Alex also showed an appreciation of diversity and a tolerance towards ambiguity. If something did not work, they just tried something different. The three teachers also reported that highlighting these judgments gave them an opportunity to demonstrate strategies for learning and to model to their students how to adjust after mistakes were made. Derry (2008) described this as teacher capacity of judgement. Derry pointed out that the development of capacities of judgment is not just teacher autonomy as it also includes the conditions for teachers to respond and make decisions actively. Flexibility and the ability to make judgments are further attributes of teacher capacity to entertain unfamiliar technology. The conditions for the three teachers to respond and act are explored further as external affordances.

External affordances.

Observational data suggested similar external affordances within each of the two schools. A collaborative work environment invited the teachers' capacity to learn and to support each other's learning. The two school administrators also facilitated the capacity of their teachers to entertain unfamiliar technology by giving them some opportunity to take risks. These affordances enabled the teachers' capacity to make sense of unfamiliar technology. The interview and observation data indicated the teaching and learning environment embodied four comparable characteristics of a constructivist framework as such: (a) teacher participant/learner centred construction, (b) reflected thinking about action, (c) a collaborative working environment, and (d) the view of technology as an intellectual partner.

Teacher participant/learner centred construction.

Piecing together the data from the two schools suggested that student learning began as a personal act of building knowledge, not the act of acquiring knowledge. Learning was a process where the teacher's role was to present problems that stimulated curiosity and assisted students in making connections. The learning activities observed focused on student-centred construction yet Sarah and Alex were responsive to student feedback; they adjusted and participated in learning activities to meet the needs of their students. These learning experiences directly linked with Derry's (2008) new notion of knowledge. This was evident with Alex in The Canada Project who was unsure of the outcome as students were rebuilding Canada. Direct teaching was a strategy to support knowledge construction rather than transmission. Sarah focused on the process of learning mathematics concepts not just on getting the right answer. Sarah's hope was that with an emphasis on strategy, students would learn to become better risk takers. This focus also links with Howland et al.'s (2012) explanation of meaningful learning. As Jonassen (1992)

highlighted, constructivist models of instruction are designed to create environments where learners actively participate. The observation data indicated active learning focused on the process of discovery, in which the students sought to understand issues that Sarah and Alex brought to their attention.

Reflected thinking-about-action.

As humans we interact with our experience and seek to understand these interactions with reflective thinking about this action (Jonassen et al., 2000, p. 107). The interview and observation data revealed that the three teachers sought to understand and challenge their students' thinking. McKenzie (2000) argued that questions are critically important as they enable us to solve problems and make sound decisions. The three teachers valued their students' ability to ask questions as well as to develop and evaluate strategies to solve problems. In Sarah's class, students brought their own questions to the community structures they built in their community project. In Alex's class, The Canada Project used dilemmas and scenario-game-based quests instead of offering ready-made solutions. Thomas said learning was not about rote memory. The end result he felt was in the students' ability to learn and judge for themselves what was truth, not about knowing information intrinsically. This strategy followed a process that Jonassen (1994) called experiential and reflective. This parallels what was described by UNESCO (2005) as the problem-solving model and Denning and Dunham's (2010) powerful learning cycle. The three teachers, with their students as knowledge seekers were required to learn to make judgements about their discoveries and the tools they used to solve them.

In the student debriefing that I observed, Sarah and Alex provided opportunities for their students to reflect on their choices and be responsive to errors. The three teachers did not tell students that the iPad was a good or bad choice in terms of completing their tasks. Rather, the

students discovered for themselves the merits of their decision. The observational data revealed careful deliberation by Sarah and Alex before, during, and after learning activities. This finding relates to Ketelaar et al.'s (2012) explanation of sense-making. The reflection helped the community of learners make sense of their experience with their technology choice.

Walter's and Gerson's (2007) assertion is that the act of making purposeful choice is a fundamental component of learning. This was observed in the two classrooms when Sarah and Alex focused on individual construction with an emphasis on student choice but allowed for multiple perspectives and representations. The three teachers wanted to have a collection of technology from which to choose and insisted that their students grapple with their technology choices. Sarah voiced the idea that the real power of personal choice came when her students started to think about their choice of technology. Sarah said that by giving her students experience in making a choice about what works for them and perhaps more importantly what does not, the choice became, as she said, a "big thing". Sarah said giving students choice helped her to understand their learning style. Because of this, she built into her day plan an opportunity to reflect on the successes and struggles with why choices did and did not work.

The three teachers valued the diverse learning styles in their students, and provided opportunities for students to personalize their learning. During classroom observation, Sarah and Alex did not treat each student the same or expect the same from each student. Thomas spoke about his and Sarah's concern to individualize for students ways to connect with a topic. Observational data of mathematics problem-solving activities and The Canada Project also revealed that Sarah and Alex valued a kind of knowledge that recognized learning as open-ended, improvised, participatory, and rooted in negotiation. These findings map what Schrum et al. (2008) found—that computers support autonomy because each student could choose his/her

own level of difficulty and pace to complete an assignment. This autonomy allowed for student voice in personalized learning.

Collaborative environment.

The interview and observation data suggested that sense making of the iPad occurred in context for the three teachers with their students. During classroom activities during the observation period students had of choice between pencil and paper, computer, or iPad. Ketelaar et al. (2012) also found that sense making occurs both within the individual and the total social environment. In addition, students made decisions with learning partners about their choices of what technology might support their learning needs. Observational data indicated that interactions between Sarah, Alex and their students in the day-to-day learning activities led to a shared understanding of technology's value. Sarah and Alex did not know the value of the iPad to support the teaching and learning process until the students did. In addition the three teachers met with the other teachers in The iPad Project once a month giving them an opportunity to share concerns and success with each other on a regular basis.

All three teachers reported that they did not feel like knowledge authorities in the classroom and their learning did not compete with students' learning. The three teachers reported that they would make sure the students noticed when they made a mistake. Sarah said her role was not to be the one with the right answers, but to model how to seek and how to respond when mistakes were made. Thomas talked about the importance of developing a democratic classroom in which the students would depend on each other and not just on the teacher to find answers. Alex reported how much he enjoyed it when students came to him all excited over knowing something he did not. The observational data indicated that Sarah and Alex were confident with their ability to explore unfamiliar technology. The two teachers were willing to put aside their

egos in front of their students in relation to being authorities of knowledge. Schrum et al. (2008) might have described these three teachers as being *tech-savvy* teachers because of a willingness to place learning ahead of personal pride.

Teachers will not always have a say in what technologies they must use. Sense making then is not just a matter of accepting or rejecting unfamiliar technology. Ketelaar et al.'s (2012) findings indicated teachers' sense making of innovation [new and emerging technology] depended on whether its application reinforces or challenges the teachers' beliefs about learning and what they perceive their role to be in the teaching and learning environment. The three teachers in my study reported that they first made sense of the iPad by experiencing its use as a personal device. Alex even said participating in the iPad Project was fun. When they participated in The iPad Project, they were treated as learners first (Crichton et al., 2012). As learners all of the teachers in The iPad Project took time to play with the iPad as a personal device in an informal learning environment prior to its introduction at their schools. This gave teachers in The iPad Project an opportunity to form a positive relationship with it before bringing it to the students. This also parallels what Zhao, Frank, and Ellefson (2006) found--that teachers require experience experimenting with technology so that they can make mistakes without embarrassment. Further, the three teachers seemed to see its real potential by adding it to the classroom collection of digital devices and letting their students decide for themselves what technology was the right choice to serve their needs.

Technology as an intellectual partner.

The observational data suggested the teaching and learning environment in Sarah and Alex's classrooms had a learning-driven focus. Their approach with technology was not a technocentric one. While the three teachers reported that the students seemed to be attracted to

the hype of the new iPads in the early days of the project, they all said it seemed to pass as the students began to focus more on the learning task than on the tool. The three teachers also reported that their students had choice among the ample technology provided by the school and in some cases in their homes.

Similar to Howland et al. (2012), observations in Sarah's and Alex's classrooms indicated that they made technology in general available to their students to support meaningful learning. Sarah and Alex followed a student-centred approach: students used technology as an intellectual partner to support knowledge construction through representation. In this regard the role of technology was similar to the process view described in the literature review. In addition, Sarah and Alex accessed technology as an information vehicle for students to explore knowledge, a tool to support learning by doing, a social medium for collaboration, and a tool to support learning through reflection. Observational data indicated technology was used by Sarah and Alex and their students to capture information to construct personal representations of meaning. For example, Sarah and Alex took advantage of any technology at their disposal such as their personal iPhones to capture, record, and time events in the classroom. Students learned by doing with computers and iPads to express themselves. Students represented grade level real world situations in the Community and Canada Projects. As an information vehicle, document cameras, computers, LCD projectors, and Interactive Whiteboards were accessed by Sarah and Alex to mediate learning and spark creative thinking in students and were used to assist visual presentations. Student use of technology was often learner initiated and learner controlled and generally used in a collaborative manner. For example, iPads were used by Sarah's students in partners to brainstorm, organize, and present story ideas. Students in Alex's class attempted in small groups to use iPads to collect and publish information. Again the interview and

observation data indicated that the three teachers recognized that if the iPads were to be of service, then the devices would have to support a learning need.

Constraints.

It was evident from observation that constraints did not overpower Sarah's and Alex's ability to make sense of the iPads. The interview and observation data did, however, suggest that constraints came as frustrations from outside of the three teachers' control. For example, Thomas reported that he did not want participant observation in his classroom due to stress from the evaluation process. Sarah reported frustration with limited time in the work day to explore unfamiliar technology. She said teachers had limited opportunities to connect and support each other as they worked with the unfamiliar technology. In addition, the learning management tool Desire2Learn™ (D2L) that was accessed in Sarah's and Thomas' professional learning was reported to be an accountability tool. According to Sarah, the school administration did not take advantage of D2L's participatory knowledge-building capabilities to support the community of teacher learners in her building. Further the interview data at both schools and observations during Sarah's and Thomas's PLC meeting suggested that they had inconsistent opportunity for personalization of their own learning. As well, Alex reported that he did not feel he had ownership of his professional learning and expressed a concern for what he felt was a scolding tone used by a school district leader in a professional development video.

The observational data from both schools indicated that introducing the iPad challenged the infrastructure to accommodate it. The current infrastructure severely limited the potential use of the iPad. Technical constraints that included filters that blocked all personal devices from printing, watching video, and accessing email impacted how the iPad could be used, thus making it impossible for the three teachers to assess work created by students on the iPads properly.

Students were then required to hand in the iPad itself so their work could be marked. D2L also did not recognize the iPad and in some cases the Internet connection was unstable which caused another challenge to be addressed.

Educational technology research has shown that some programs targeted toward classroom technology integration have not been successful (Cuban, Kirkpatrick, & Peck, 2001; Derry, 2008; Glassett & Schrum, 2009). In these studies, the dominant barriers for teachers were lack of time, lack of training, lack of technical support, and general resistance. However a framework of affordances provides a view beyond barriers with an aim to build pathways for teachers. The capacity to entertain unfamiliar technology resides in teachers' own capacity to act and participate in their own learning of technology.

The Implementation Of A New Technology In Teaching And Learning

The second research question asks: *How might these teachers' insights inform strategies to support the implementation of new and emerging technology in teaching and learning?* In dealing with the first research question, I presented the three teachers' personal insights as an interconnected voice. The second research question extends the first, as three lessons learned from this interconnected voice.

The key finding from the data was that teacher capacity was the most frequent enabler for the three teachers to make sense of unfamiliar technology. The three teachers, each in their own way, made sense of the iPad within a similar collection of external affordance and constraints. They did so mainly through their own determinations. The key lesson taken from this finding is that, it is unlikely that the implementation of any new technology will be successful without, first, a willingness on the part of the teacher to entertain unfamiliar technology. The greater educational community can support the implementation of new and emerging technology by

bolstering teachers' capacity to deal with it. A second lesson recognizes that teachers (not the technology) are agents of change in practice. It is essential to invite teacher participation into the implementation process and to listen to their concerns. The third lesson acknowledges implementation is a learning process. One size will not fit all; as learners, teachers need to personalize their approach to unfamiliar technology.

Willingness

The study recognized willingness as part of teacher capacity as a complex intrinsic and internal capability. The three teachers displayed a willingness to entertain unfamiliar technology as an openness to possibilities and a commitment to life-long learning. They wanted to engage in the use of unfamiliar technology and they demonstrated a willingness to learn about the iPad with their students. The observation data also suggested the context welcomed the three teachers' willingness to learn, and reinforced their belief that technology was used to support the teaching and learning process. The three teachers worked within external affordances such as: a collaborative work environment; ample technology to provide their students with choices; a network structure and IT support for the technology; and opportunities for learning in The iPad Project. Within this framework, the three teachers were provided with support and invited to imagine the potential of the iPad with regard to teaching and learning. In general, it was found that teachers must be willing participants, but their capacity to use or even entertain the unfamiliar will benefit from a collection of external affordances.

Teacher participation

For the three teachers in the study, their capacity was connected within a framework of enablers including both affordances and constraints. This framework recognizes that there will always be constraints when introducing a new technology into an established learning

environment. At the same time, these constraints were conditions that affected the three teachers' ability to act. In order to support the implementation of new and emerging technology, the environment must invite or provide facility for teacher participation in the implementation process. The observation and interview data suggested that there was also limited time for the teachers to explore unfamiliar technology in the work day. Sarah expressed frustration in having the skill and experience to support her fellow teachers to learn how to use technology to support meaningful learning but having no time in her day to do so. Thomas talked about stress from evaluation and there being no time for anything extra, and Alex expressed his frustration in not owning his own learning. In addition to these constraints to learning, Internet filtering also made accessing YouTube awkward and time consuming on computers and impossible on the iPad. Further the infrastructure greatly reduced the potential of the iPad to publish student-generated work. Constraints can limit the range of allowable action (Zhang & Patel, 2006). Therefore, constraints should be attended to in a timely manner.

According to Hargreaves (2003), teachers are the key agents of change. Without teachers' confidence and competence, "the future will be malformed and stillborn" (p. 160). If new and emerging technology is to be implemented, teachers need opportunities to understand technological constraints in general and to be provided some facility to address them in their work day. Teacher experience must be valued and teacher concerns must be considered by those who control these constraints.

Personalizing the experience

One size will not fit all when looking to implement new and emerging technology. According to Zhao, Frank, and Ellefson (2006), research has suggested that the ability to teach with technology encompasses a broad set of qualities, enabling conditions, and access to

assistance. Also, as Levin and Wadmany (2008) found in their study of teachers' views on factors affecting their use of information and communication technologies, "we should also consider the broader profile of teachers' educational beliefs, their cognitive and emotional disposition to face novel, uncertain, situations, their actual teaching practices, and their views on technology and its supportive and restrictive nature" (p. 234). The process of implementation will benefit if teachers can build personal pathways for sense making of new and emerging technology.

The observational data suggested that the teaching and learning environment, while supportive of teacher learning, provided inconsistent opportunities for the three teachers to personalize their learning, take ownership of their learning, and support each other. If as Levin and Wadmany (2008) have suggested, we conceptualize the adoption of technology as a learning process, then the implementation of new and emerging technology without recognizing the teacher as learner is fruitless. The constructivist tradition of education which regards learning as complex, interactive, changing, active, and situated "is not only applicable to students, but to teachers as well" (Levin & Wadmany, 2008, p. 258). Teachers must be treated as active learners who construct their own understanding. The learning must be, as Borko (2004) suggested, situated in the context of the teaching day. In order for successful implementation of new technology, teachers need to experience the same affordances that they themselves provide for their students by following constructivist learning principles in their professional development.

Implications

The key findings of the study reveal an enhanced understanding of the potential of the capacity of teachers within a constructivist teaching and learning environment. The value of the iPad did not drive its use in the classroom. Rather, it was the pursuit of knowledge that

determined how and why the iPad was used. The implications of this suggest it is not enough to focus only on the device when making sense of new and emerging technology. If the journey is valued over the arrival, if curiosity is valued over the object discovered, if exploration is valued over acquisition of knowledge, and if we shift the value away from the technology as these teachers did, something different happens. Most importantly, placing this understanding within a framework of enablers highlights for the greater educational community an interconnected responsibility for school district administrators, school administrators, and teachers to develop meaningful professional development and supportive professional learning communities which will be the focus for the subsequent sections.

School District Administrators

Networked-based learning environments often require resources beyond the teacher's control and expertise. The data indicated that use of the iPad challenged the infrastructure to accommodate it and that outside control of computer administration frustrated teachers. Throughout the literature reviewed, the suggestion has been that supplying teachers with new technology is not enough to support the use of technology in the classroom (Cuban et al., 2001; Schrum et al., 2008; Zhao et al., 2006). The implication for school districts is to examine the constraints teachers encounter from the teachers perspective when using the new technology. Addressing the constraints also implies the development of a more flexible, supportive infrastructure to accommodate new and emerging technology. Consideration of more local control of constraints in schools themselves could reduce the wait time for updates of software and provide some control to teachers themselves. In addition IT support should focus on what teachers identify as concerns. In return, technicians should provide information about the

capacity of the technology in relation to these teacher concerns with the goal being to solve issues in the classroom within the work day in a timely manner.

School Administrators

Teachers cannot give what they have not experienced. The literature has suggested that professional learning is ineffective when it treats teachers as passive recipients of others' expertise (Edwards, 2012; Hargreaves, 2003; MacDonald & Shirley, 2009). The implication for school leaders is to consider how to invite teacher capacity, first to entertain and then to use unfamiliar technology as what Jonassen et al. (1998) called an intellectual partner in the process of teaching and learning. Research suggests that teachers need experience to be able to see technology's potential to solve pedagogical problems (Zhao et al., 2006). Recognizing the importance of treating teachers as learners initially gave the three teachers time to explore the iPad as a personal device prior to its introduction to the classroom. The teachers called this learning "fun". At the same time, addressing tacit knowledge built from meaningful experience needs to be valued. Effective professional development should draw on teachers' own creativity and the school's resources, and should be delivered in the school and within the teachers' classroom context. School leaders need to be aware that providing teachers with sense making opportunities to play with technology in their own classrooms in collaboration with other teachers during the school day may be an effective professional development experience for teachers.

The interview and observational data indicated that the three teachers made sense of unfamiliar technology within a constructivist teaching and learning environment and that it was made possible through a framework of enablers. The three teachers made sense of the iPad as a process with others in context. Research has suggested that collaborative environments support

teachers in understanding the unfamiliar better and in strengthening their feelings of ownership (Ketelaar, et al., 2012; Wood, 2007). A role for school leaders is to provide teachers with opportunities to collaborate to build personal learning communities structured on what they perceive as their own needs.

Teachers

It is important to recognize that the key agent of change is people, not technology. Although the study presented the voices of only three teachers, Sarah's, Thomas's, and Alex's individual experiences are connected to the findings of other larger studies. However it is clear that teachers who are not tech-savvy require support. The study underlines the importance of teachers' participation in the process of teaching and learning. However tempting it might be to focus on the hype and glamour of new gadgets, the focus should remain on the process of teaching and learning. The implication for teachers is a commitment to life-long learning, a willingness to act, and an openness to possibilities. Teachers who do not have the opportunity to see themselves as learners will find it more and more difficult to cope with the ever-changing landscape influenced by educational technology.

Therefore, there is a need to empower teachers with dynamic professional development experiences that are personally meaningful and also connected in a collaborative culture of lifelong learning. This may occur through the following three strategies: (a) providing more opportunities to experiment with new technology as a personal device prior to its use in the classroom as was done with The iPad Project; (b) creating more opportunities for mentoring or pairing tech-savvy teachers with those who are not; (c) finding ways for teachers to have at the moment of need learning opportunities such as opening up connections to professional learning networks through social media.

Overview of implications.

The implication is that there needs to be a commitment by school districts, school administrators, and teachers to work towards a constructivist teaching and learning process that calls for teacher participation in a shared sense of capacity. Effective professional development and IT support needs to be a collaborative process that focuses on teaching and learning with technology with a clear link to the realities of the classroom. A framework of enablers highlights an interconnected responsibility that also creates time during the work day within the context of their ongoing tasks to support teachers working with unfamiliar technology.

Summary

This chapter has provided a response to the two research questions based on the data and was mapped to relevant literature. It was evident that specific enablers are needed to support teachers if they are to be successful in supporting learning within a technology-enabled environment. However, teachers also require the capacity to be able to work within normal constraints in ways that do not negatively impact the learning experience. From the data, I have identified three key implications that need to be addressed by school districts administrators, school administrators, and teachers. These implications have highlighted the interconnected responsibility of school districts, school administrators, and teachers to build teacher capacity for action.

Chapter Six: Concerns and Future Considerations

This case study was designed to explore how teachers might make sense of unfamiliar technology and to offer suggestions of support in the implementation of new and emerging technology in teaching and learning. This chapter concludes the dissertation by providing an overview of the nature of the study, a summary of the findings, implications of the interconnected responsibility for teacher capacity and, finally, concluding remarks and recommendations for directions of future research.

Nature Of The Study

Intersecting changes in a new notion of knowledge, the rise of the knowledge economy, the rapid pace of technological change, and a continuing evolution of the role of teacher suggests that teachers have been challenged to entertain new and emerging technology in their classrooms. I was concerned with understanding these intersecting issues as teacher experience. My primary intent in the case study was to develop an experiential understanding of how teachers might make sense of new and emerging (unfamiliar) technology as a process.

The study was designed as a holistic approach with several synergetic goals while focusing on developing experiential understanding through rich description. When teachers engage with unfamiliar technology for meaningful learning and share their experiences, then the greater educational community may benefit from understanding this unique perspective. It is through such research, as conducted in this study, that teachers' insights and experiences may help to inform the larger educational community.

Research Design

Given the complexity of human behaviours, attitudes, and beliefs, the study was designed to utilize a descriptive case study methodology. This approach was an effective strategy to capture the openness of experience in its natural setting. What came from getting to know the *case* was, first, an enhanced understanding of the capacity of teachers and the potential of the constructivist environment that invited facility. Second, the case provided a rich description of the framework of enablers for teachers to use unfamiliar technology. Third, it provided an awareness of the interconnected responsibilities to bolster teacher capacity. The research design supported the collection and analysis of data in the study that addressed the case study's two research questions.

1. How do teachers make sense of new and emerging technology to enhance teaching and learning?
2. How might these teachers' insights inform strategies to support the implementation of a new technology in teaching and learning?

Key Findings

In this dissertation, I presented an expanded understanding of teacher experience with unfamiliar technology. The lessons learned were supported by literature and informed by evidence collected from the research study. In Chapter Four, the findings were presented as three themes: 1) a description of a constructivist teacher role of *architect of learning*; 2) a description of a collection of enablers for teacher capacity; and 3) constraints for teachers to make sense of new and emerging (unfamiliar) technology.

In Chapter Five the findings were discussed and key issues emerged from the data to support a framework of enablers and an interconnected responsibility to bolster teacher capacity.

The data indicated that teachers can make sense of unfamiliar technology within a constructivist environment that reinforces their beliefs about teaching and learning. The data also suggested that this constructivist teaching and learning environment can support the development of teacher capacity to use unfamiliar technology. In this section of Chapter Six key findings are highlighted in relation to the framework of enablers for teacher capacity to make sense of unfamiliar technology.

Teachers Role

The three teachers made sense of the iPad with their students as intellectual partners, not by making the technology the centre of their teaching but by focusing on meaningful learning with technology as suggested by Howland et al. (2012). The data established that the role of architect embodied a constructivist teaching and learning environment. In this role the three teachers were asked to plan, design, make choices about student-centred learning activities, and oversee them. This role required teachers to use technology in ways that they were not taught as students. The three teachers demonstrated a willingness to entertain unfamiliar technology with their students and to participate in the teaching and learning process as they thought of themselves as learners. The data also suggested that a constructivist teaching and learning environment bolstered their capacity to use unfamiliar technology.

Enablers

The three teachers in the study were seen to be tech-savvy in that they devoted extra attention to the use and skill with technology to support teaching and learning. They were free to design and assess student learning experiences within their own classrooms. While the study found that teacher capacity was the most frequent enabler, the three teachers functioned within a framework of internal and external enablers. Enablers were seen as distributed throughout the

environment as teacher capacity, an internal quality from the individual teacher, and external affordances, qualities from the environment such as what the school district and school administration offered, what it constrained, what it provided, and what it invited. As found in the data, the environment embodied a constructivist framework and invited the three teachers to take ownership over their technology choices in the classroom.

Tensions

In Chapter Four the data revealed that tensions for the three teachers came from situations outside their control such as limited time to explore unfamiliar technology, Internet filters, restrictive infrastructure, limited opportunities to support each other with technology, and limited personalized teacher learning. When looking at the frequency of themes, I discovered that these tensions were not seen as barriers for these teachers to entertain unfamiliar technology but as constraints. While these situations were frustrating, the teaching and learning environment permitted allowable action for these teachers to make sense of unfamiliar technology. The data also suggested that the teachers used their capacity to respond to these constraints.

In Chapter Five a process view served to imagine potential pathways for teacher capacity. A framework of enablers emerged as a view beyond barriers for teachers to use new and emerging technology. Constraints were not seen as barriers in opposition of the enablers. The teaching and learning environment invited teachers as participants in the teaching and learning process. As participants, teachers had the capacity to act within their environment, thus the weight of the constraints was diminished.

Interconnected Responsibilities

The framework of enablers outlined in Chapter Five highlighted an interconnected responsibility for school districts, school administrators, and teachers to nourish the development

of teacher capacity. The implication is that it is not enough for the greater educational community to focus only on the device when making sense of new and emerging technology.

As I wrote this dissertation, several questions arose around these interconnected responsibilities as follows:

1) For school districts, is the jurisdictions' human and technology infrastructure flexible enough to cope with new and emerging technology? How are teachers allowed to grapple with constraints within their teaching and learning environment?

2) For school administrators, how does your current teaching and learning environment invite the development of teacher capacity? How do you provide teachers with similar affordances for learning that they are asked to provide for their students? As *architects of learning*, teachers are asked to design activities that meet the diverse learning needs of their students. How are your teachers able to personalize their own learning? While technological change continues to accelerate and take a broader role in our classrooms, how is time provided for teachers to make sense of unfamiliar technology within their work day?

3) For teachers, how do you think of yourself as a learner? How does your commitment to life-long learning reveal itself in your teaching? What opportunities do you create to learn in front of your students, so as to take advantage of their experience to engage with new and emerging technology?

Recommendations For Future Research

From the study there emerged three areas worthy of future exploration to expand the understanding of teacher capacity with new and emerging technology. These areas are recommended for future research:

A Different Research Methodology

Case studies are good for helping us understand what is happening in complex settings (Yin, 2009). However, case study methodology is not intended to intervene or support the implementation of something like new and emerging technology. In order to gain a more comprehensive understanding of the adoption process, a similar study is needed with a design-based research focus to look beyond the tool and focus on technology's purpose in supporting the activity of teaching and learning. To achieve this, more effort needs to be focused on teacher experience and not on technology (Ertmer & Ottebreit-Leftwich, 2012). As a methodology, design-based research (DBR) seeks to increase the impact of research on improved practice and stresses the need for theory building (Anderson & Shattuck, 2012). DBR recognizes the complexity of interactions that occurs in classrooms. According to Amiel and Reeves (2008) with its continuous cycle of design-reflection-design, DBR can highlight complex interactions in real contexts and systematic collaborative methods with teachers. The DBR approach would focus first on developing an effective learning environment so that teachers would become confident in using unfamiliar technology and then use that environment as a place from which to understand the implementation process of new and emerging technology. DBR might provide an understanding of how a less tech-savvy teacher might develop the capacity to entertain unfamiliar technology.

Questions to guide the inquiry:

1. How can teachers build capacity to entertain unfamiliar technology?
2. What options are there for teachers to participate in how unfamiliar technology is accessed to support meaningful learning?
3. How might these options be established and sustained?

Developing Teacher Capacity through Professional Development

Further research needs to be done about developing teacher capacity while recognizing that technology is not a tool that enables constructivism, but rather a pathway to enable learners to gain deeper understanding of their queries.

Questions to guide the inquiry:

1. What factors influence how professional development enables teachers to integrate technology in ways that support constructivist principles?
2. How might non-tech-savvy teachers respond if given time to make sense of unfamiliar technology collaboratively within their work day?

A Framework of Enablers for Teacher Capacity

Further research needs to be done about establishing and sustaining positive learning environments that support a culture of capacity building. Recognizing an interconnected responsibility, future researchers should explore how school districts, administrators, and teachers might facilitate teacher capacity building in order to gain more freedom in technology use.

Questions to guide the inquiry:

1. What conditions need to be in place to support the building of bridges of understanding within a framework of enablers?
2. How might teachers make sense of new and emerging technology within a framework of responsive enablers?

Concluding Remarks

The case study methodology allowed me to develop an experiential understanding of how three teachers made sense of new and emerging technology. As described in Chapter Three, I found it to be an excellent strategy to describe what was going on within a bounded system. Within the study, it was revealed that a number of similar factors enabled the three teachers to make sense of unfamiliar technology. The teachers in the study saw the value in technology-enabled teaching and learning, they had a collaborative spirit, they were identified as tech-savvy, and they saw themselves as learners. They were supported as learners by The iPad Project, the district, school administration, and colleagues. However, the study revealed that these teachers were tech-savvy and relied heavily on their own capacity to make sense of unfamiliar technology. I found the case study methodology limiting in helping me understand how to support teachers who are not tech-savvy to make sense of unfamiliar technology.

During the process of writing this dissertation, my perspective shifted away from barriers for teachers towards looking for pathways for sense making. A process view permitted me to be open to complexity and to pay particular attention to the many activities, regions, enablers, and constraints associated with the introduction of unfamiliar technology in the classroom. This perspective recognized that there will always be challenges when teachers strive to use something new. The key is to open pathways that enable teachers to grapple with constraints. What has become important is the recognition that teacher capacity is distributed within a framework of enablers and interconnected responsibilities. This focus has led to three questions: 1) What can the education system do to anticipate future development of technology and become a part of a more supportive framework of enablers for teachers? 2) How might school leaders invite non tech-savvy teachers to participate in this sort of learning? 3) How do we empower

teachers, encourage a willingness to entertain the unfamiliar, and view technology as a partner in the teaching and learning environment? Yet at the end of the day, I am left with one question. How do we open multiple connected pathways for teachers to develop the capacity to work in personalized meaningful ways with new and emerging technologies?

Dewey (1916) noted that in a democratic society we should make provision for participation. Education, Dewey envisioned, should give individuals a personal interest in social relationships and control. MacDonald and Shirley (2009) also contend that the situation for teachers only improves when they themselves have opportunities to become more reflective. As society adopts new technologies, teachers have an obligation to bring them into their classrooms. A framework of enablers includes constraints but treats teachers as participants with capacity to act. The three teachers in the study had an intrinsic need to learn and did not seem to mind learning on their own time. While the three teachers were provided with affordances for learning, most importantly they saw themselves capable of it and jumped at the opportunity to learn.

REFERENCES

Ackermann, E. K. (2004). Constructing knowledge and transforming the world. In M. Tokoro & L. Steels (Eds.), *A learning zone of one's own: Sharing representation and flow in collaborative learning environments* (pp. 15–37). Amsterdam: IOS Press. Retrieved from http://jotamac.typepad.com/jotamacs_weblog/files/Constructing_Knowledge_Ackermann2004.pdf

Alberta Education. (2012). *iPads: What are we learning?* (Summary of data gathering). Edmonton, AB. Retrieved from http://education.alberta.ca/admin/technology/research.aspx

Allen, G. (2008). *Practicing teachers and web 2.0 technologies: Possibilities for transformative learning*. Columbia University, New York.

Amiel, T., & Reeves, T. C. (2008). Design-based research and educational technology: Rethinking technology and the research agenda. *Educational Technology & Society*, *11*(4), 29–40.

Anderson, T., & Shattuck, J. (2012). Design-based research: A decade of progress in education research. *Educational Researcher*, *41*(1), 16–25.

Barab, S., & Squire, K. (2004). Design-based research: Putting a stake in the ground. *The Journal of the Learning Sciences*, *13*(1), 1–14.

Barrow, R. (2010). Schools of thought in philosophy of education. In R. Bailey, R. Barrow, D. Carr, & C. McCarthy (Eds.), *The sage handbook of philosophy of education* (pp. 21–35). Thousand Oaks, CA: SAGE.

Becker, H. J. (2000). Findings from the Teaching, Learning, and Computing Survey | Becker | education policy analysis archives. *Education Policy Analysis Archives*. Online Journal. Retrieved March 30, 2010, from http://epaa.asu.edu/ojs/article/view/442

Borko, H. (2004). Professional development and teacher learning: Mapping the terrain. *Educational Researcher*, *33*(8), 3–15.

Branch, R., & Deissler, C. (2008). Processes. In A. Januszewski & M. Molenda (Eds.), *Educational technology: A definition with commentary* (pp. 195–211). New York: Lawrence Erlbaum Associates.

Brown, J. S., & Thomas, D. (2008). The Power of Dispositions. *Ubiquity information everywhere*. Digital Library. Retrieved August 17, 2011, from http://ubiquity.acm.org/article.cfm?id=1472988

Clandinin, D. G., & Connelly, F. M. (2000). *Narrative inquiry: Experience and story in qualitative research*. San Francisco: Jossey-Bass.

Clough, P., & Nutbrown, C. (2002). *A student's guide to methodology* (2nd ed.). Thousand Oaks, CA: SAGE.

Creswell, J. W. (1998). *Qualitative inquiry and research design: Choosing among five traditions*. Thousand Oaks, CA: SAGE.

Creswell, J. W. (2009). *Research design: Qualitative, quantitative, and mixed methods approaches* (3rd ed.). Los Angeles: SAGE.

Crichton, S. (2009). Use of digital data. In A. Mills, G. Durepos, & E. Wiebe (Eds.), *Encyclopaedia of case study research*. Thousand Oaks, CA: SAGE.

Crichton, S. (2011). Using digital tools in qualitative research: Supporting integrity, simplicity, deep insight and social change. In Carlos Numes Silva (Ed.), *Online research methods in urban and planning studies*. Hershey, PA: IGI Global.

Crichton, S., Pegler, K., & White, D. (2012). Personal devices in public settings: Lessons learned from an iPod touch/iPad project. *Electronic Journal of eLearning*, *10*(1), 23–31.

Crotty, M. (1998). *The foundations of social research: Meaning and perspective in the research process*. Thousand Oaks, CA: SAGE.

Cuban, L. (2001). *Oversold & underused: Computers in the classroom*. Cambridge, MA: Harvard University Press.

Cuban, L., Kirkpatrick, H., & Peck, C. (2001). High access and low use of technologies in high school classrooms: Explaining an apparent paradox. *American Educational Research Journal*, *38*(4), 813–834.

Cunningham, C., & Allen, B. (2010). Philosophical questions about learning technologies. In R. Bailey, R. Barrow, D. Carr, & C. McCarthy (Eds.), *The sage handbook of philosophy of education* (pp. 481–502). Thousand Oaks, CA: SAGE.

Denning, P. J., & Dunham, R. (2010). *The innovator's way: Essential practices for successful innovation*. Cambridge, MA: The MIT Press.

Denzin, N. K., & Lincoln, Y. S. (2008). *Collecting and interpreting qualitative materials* (Vol. 3rd). Thousand Oaks, CA: SAGE.

Derry, J. (2008). Technology-Enhanced learning: A question of knowledge. *Journal of Philosophy of Education*, *42*(3-4), 505–519.

Dewey, J. (1916). *Democracy and education*. Stilwell, KS: Digireads.com Publishing.

Duffy, T. M., & Cunningham, D. J. (1996). Constructivism: Implications for the design and delivery of instruction. In D. H. Jonassen (Ed.), *Handbook of research for educational communication and technology* (pp. 170–198). New York: McMillan.

Edwards, A. (2012). *New technology and education*. New York, NY: Bloomsbury.

Ertmer, P. A. (2005). Teacher pedagogical beliefs: The final frontier in our quest for techno. *Educational Technology Research and Development*, *53*(2), 25–39.

Ertmer, P. A., & Ottenbreit-Leftwich, A. T. (2012). Removing obstacles to the pedagogical changes required by Jonassen's vision of authentic technology-enabled learning. *Computers & Education*, *In Press*. Retrieved from http://www.sciencedirect.com.ezproxy.lib.ucalgary.ca/science/article/pii/S0360131512002308

Ezzy, D. (2002). *Qualitative analysis: Practice and innovation*. London: Routledge.

Feenberg, A. (2002). *Transforming technology: A critical theory revisited* (Rev.). Oxford: Oxford University Press.

Fishman, B. J., & Davis, E. A. (2006). Teacher learning research and the learning sciences. In R. K. Sawyer (Ed.), *The Cambridge Handbook of the Learning Sciences* (pp. 535–550). New York: Cambridge University Press.

Flyvbjerg, B. (2006). Five misunderstandings about case-study research. *Qualitative Inquiry*, *12*(2), 219–245.

Friesen, S., & Jardine, D. (2009). 21st century learning and learners. *Western and Northern Canadian Curriculum Protocol.*, *found online*. Retrieved from http://www.google.ca/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&sqi=2&ved=0CGEQFjAA&url=http%3A%2F%2Feducation.alberta.ca%2Fmedia%2F1087278%2Fwncp

%252021st%2520cent%2520learning%2520(2).pdf&ei=V5kIUIGeLserrQHah522BA&usg=AFQjCNFj9vCWD4A1u2n2R4QZX1y8UZkbCg&sig2=aq1GrbBgoFZxigHc_7tWzw

Gardner, H. (2007). *Five minds for the future*. Cambridge, MA: Harvard Business School Press.

Garland, J. (1964). *For once in my lifetime*. London Palladium: Capital.

Gibson, J. J. (1977). The theory of affordances. In R. Shaw & J. Bransford (Eds.), *Perceiving, Acting, and Knowing: Towards an Ecological Psychology* (pp. 67–82). Hillsdale, NJ: Lawrence Erlbaum Associates.

Glassett, K., & Schrum, L. (2009). Teacher beliefs and student achievement in technology-rich classroom environments. *International Journal of Technology in Teaching and Learning*, *5*(2), 138–153.

Government of Alberta. (2010a). *Inspiring education: A dialogue with Albertans*. Edmonton, AB. Retrieved from http://education.alberta.ca/department/ipr/inspiringeducation.aspx

Government of Alberta. (2010b). *Inspiring action on education: A discussion paper*. Edmonton, AB. Retrieved from http://engage.education.alberta.ca/uploads/1006/20100621inspiringact86934.pdf

Government of Alberta. (2011). Alberta Initiative for School Improvement (AISI). *Education*. Retrieved March 14, 2012, from http://www.education.alberta.ca/department/ipr/aisi.aspx

Hansen, D. T., & Laverty, M. J. (2010). Teaching and pedagogy. In R. Bailey, R. Barrow, D. Carr, & C. McCarthy (Eds.), *The sage handbook of philosophy of education* (pp. 223–235). Thousand Oaks, CA: SAGE.

Hargreaves, A. (2003). *Teaching in the knowledge society*. New York: Teachers College Press.

Harris, J. (2005). Our agenda for technology integration: It's time to choose. *Contemporary Issues in Technology and Teacher Education [Online serial]*, *5*(2).

Hickman, L. (1992). *John Dewey's pragmatic technology*. Bloomington: Indiana University Press.

Hickman, L. (2002). Larry Hickman lecture on John Dewey, democracy, and global citizenship. *Democracy and Global Citizenship*. Lecture. Retrieved May 12, 2010, from http://www.ikedacenter.org/thinkers-themes/thinkers/lectures-talks/hickman-lecture

Howland, J., Jonassen, D. H., & Marra, R. M. (2012). *Meaningful learning with technology* (4th ed.). Boston, MA: Pearson.

Ihde, D. (1993). *Philosophy of technology: An introduction*. New York: Paragon House.

Ihde, D. (2004). Philosophy of technology. In P. Kemp (Ed.), *World and Worldhood* (pp. 91–108). Printed in the Netherlands: Springer.

International Society for Technology in Education. (2011). ISTE | NETS for Teachers. *iste.nets Advancing Digital Age Teaching*. Retrieved July 19, 2012, from http://www.iste.org/standards/nets-for-teachers.aspx

Januszewski, A., & Molenda, M. (2008). *Educational technology: A definition with commentary*. New York: Lawrence Erlbaum Associates.

Jardine, D. W. (1992). The fecundity of the individual case: Considerations of the pedagogic heart of interpretive work. *Journal of Philosophy of Education*, *26*(1), 51 – 61.

Johnson, L., Adams, S., & Cummins, M. (2012). *NMC horizon report: 2012 K-12 edition*. Austin, TX: The New Media Consortium.

Jonassen, D. H. (1992). Evaluating constructivistic learning. In T. M. Duffy & D. H. Jonassen (Eds.), *Constructivism and the technology on instruction: A conversation* (pp. 1–16). Hillsdale, NJ: Lawrence Erlbaum Associates.

Jonassen, D. H. (1994). Technology as cognitive tools: Learners as designers. *ITFORUM Paper 1*. Retrieved June 21, 2012, from http://it.coe.uga.edu/itforum/paper1/paper1.html

Jonassen, D. H., Carr, C., & Yueh, H.-P. (1998). Computers as mind tools for engaging learners in critical thinking. *TechTrends*, *43*(2), 24–32.

Jonassen, D. H., Hernadez-Serrano, J., & Choi, I. (2000). Integrating constructivism and learning technologies. In J. M. Spector & T. M. Anderson (Eds.), *Integrated holistic perspectives in learning instruction and technology. Understanding complexity* (pp. 103–129). Hingham, MA: Kluwer Academic Publishers.

Kennewell, S. (2001). Using affordances and constraints to evaluate the use of information and communication technology in teaching and learning. *Journal of Information Technology for Teacher Education*, *10*(1-2), 101–116.

Ketelaar, E., Beijaard, D., Boshuizen, H. P. A., & Den Brok, P. J. (2012). Teachers' positioning towards an educational innovation in the light of ownership, sense-making and agency. *Teaching and Teacher Education*, *28*(2), 273–282. doi:10.1016/j.tate.2011.10.004

Levin, T., & Wadmany, R. (2008). Teachers' views on factors affecting effective integration of information technology in the classroom: Developmental scenery. *Journal of Technology and Teacher Education*, *16*(2), 233–263.

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*. Newbury Park, CA: SAGE.

MacDonald, E., & Shirley, D. (2009). *The mindful teacher*. New York: Teachers College Press.

McCrory, R. (2006). Technology and teaching: A new kind of knowledge. In E. A. Ashburn & R. E. Floden (Eds.), *Meaningful learning using technology* (pp. 141–160). New York: Teachers College Press.

McKenzie, J. (2000). *Beyond technology: Questioning, research and the information literate school*. Bellingham, WA: FNO Press.

McNeil, J. D. (2009). *Contemporary curriculum: In thought and action*. University of California, Los Angeles: John Wiley and Sons.

Meier, S. (2010). Civilization V - INFORMATION. *Civilization*. Retrieved February 13, 2012, from http://www.civilization5.com/#/information/

Merriam, S. B. (2009). *Qualitative research: A guide to design and implementation*. San Francisco: Jossey-Bass.

Miles, M. B., & Huberman, M. (1994). *Qualitative Data Analysis* (2nd ed.). Thousand Oaks, CA: SAGE.

Mishra, P., & Koehler, M. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record*, *108*(6), 1017–1054.

Molenda, M. (2008). Using. In A. Januszewski & M. Molenda (Eds.), *Educational technology: A definition with commentary* (pp. 141–173). New York: Lawrence Erlbaum.

Molenda, M., Rezabek, L., & Robinson, R. (2008). Facilitating learning. In A. Januszewski & M. Molenda (Eds.), *Educational technology: A definition with commentary* (pp. 15–47). New York: Lawrence Erlbaum.

Olsen, J., Recker, M., Robertshaw, B., Sellers, L., & Walker, A. (2011). Designing for problem based learning: A comparative study of technology professional development. *The Instructional Architect Research Group*, (Paper 7). Retrieved from http://digitalcommons.usu.edu/iagroup/7

Otoshi, K. (2010). *Zero*. Berkeley, CA: KO Kids Books.

Papert, S. (1993). *The children's machine: Rethinking school in the age of the computer*. New York: Basic Books.

Richardson, L., & St. Pierre, E. A. (2008). Writing: A method of inqury. In *Collecting and interpreting qualitative materials* (Third., pp. 473–499). Los Angeles, London, New Helhi, Singapore: Sage Publications.

Sawyer, R. K. (2006). The new science of learning. In *The Cambridge handbook of the learning sciences* (pp. 1–16). Cambridge: Cambridge University Press.

Sawyer, R. K. (2008). Optimizing learning: Implications of learning sciences research. In *Learning in the 21st Century: Research, Innovation and Policy* (pp. 45–62). Presented at the OECD/CERI International Conference, Centre for Research and Innovation: OECD Publishing.

Schoepp, K. (2004). *Technology integration barriers in a technology-rich environment: A CBAM perspective*. University of Calgary Graduate Division of Educational Research, Calgary, AB.

Schrum, L. (2005). Technology as a tool to support instruction. *Education World*. Retrieved May 1, 2010, from http://www.educationworld.com/a_tech/tech/tech004.shtml

Schrum, L., Shelly, G., & Miller, R. (2008). Understanding tech-savvy teachers: Identifying their characteristics, motivation and challenges. *International Journal of Technology in Teaching and Learning*, *4*(1), 1–20.

Schwandt, T. A. (2007). *The SAGE dictionary of qualitative inquiry* (Vol. 3). Los Angeles: SAGE.

Seidman, I. (2006). *Interviewing as qualitative research: A guide for researchers in education and the social sciences* (3rd ed.). New York: Teachers College Press.

Shepherd, C. (2011). *The new learning architect*. Amazon Digital Services, Inc.: Onlignment.

Stake, R. E. (1995). *The art of case study research*. Thousand Oaks, CA: SAGE.

Stake, R. E. (2006). The case study method in social inquiry. In M. David (Ed.), *Case Study Research* (Vol. II, pp. 123–140). Thousand Oaks, CA: SAGE Publications.

Underhill, A. (1989). Process in humanistic education. *ELT Journal*, *43*(4), 250–260.

UNESCO. (2005). *Towards knowledge societies* (PDF). Retrieved from unesdoc.unesco.org/images/0014/001418/141843e.pdf

UNESCO. (2008). Why a summit on the information society. *World Summit on the Information Society*. Retrieved July 18, 2012, from http://www.itu.int/wsis/basoc/why_print.html

Varghese, N. V. (2011). Globalization and cross-border education: Challenges for the development of higher education in Commonwealth countries. *UNESCO publication*.

Von Glasersfeld, E. (1989). Cognition, construction of knowledge, and teaching. *Sythese*, *80*(1), 121–40.

Walcott, H. F. (2001). *Writing up qualitative research* (2nd ed.). Thousand Oaks, CA: SAGE.

Walter, J. G., & Gerson, H. (2007). Teachers' personal agency: Making sense of slope through additive structures. *Educational Studies in Mathematics*, *65*(2), 203–233.

White, D., Crichton, S., & Pegler, K. (2010). *Is your school ready for mobile learning?* Calgary, AB: Calgary Board of Education.

Willis, J. (2001). Foundational assumptions for information technology and teacher education. *Contemporary Issues in Technology and Teacher Education [Online serial]*, *1*(3), 305–320.

Willis, J. (2008). *Qualitative research methods in education and educational technology*. Charlotte, NC: Information Age.

Wood, D. R. (2007). Professional learning communities: Teachers, knowledge, and knowing. *Theory into Practice*, *46*(4), 281–290.

Yin, R. K. (2009). *Case study research: Design and methods* (4th ed., Vol. 5). Thousand Oaks, CA: SAGE.

Zhang, J., & Patel, V. L. (2006). Distributed cognition, representation, and affordance. *Pragmatics & Cognition*, *14*(2), 333.

Zhao, Y., & Frank, K. (2003). Factors affecting technology uses in schools: An ecological perspective. *American Educational Research Journal*, *40*(4), 807–840.

Zhao, Y., Frank, K., & Ellefson, N. (2006). Fostering meaningful teaching and learning with technology: Characteristics of effective professional development. In E. A. Ashburn & R. F. Floden (Eds.), *Meaningful learning using technology: What educator's need to know and do* (pp. 161–179). New York: Teachers College Press.

APPENDIX A: INTERVIEW QUESTIONS

Teachers are being asked to shift their practice from knowledge authority to architect of innovative learning environments. For my doctoral research I am interested in how teachers make sense of this experience with innovation. To help me understand your experience in all of this I first need to explain some of my thinking:

Teachers are unique; we come into school with a unique set of beliefs and values. At the same time **teachers share a common understanding** in a common land. Because of this, "*stories of teacher experience*" have the capacity to become like teachers themselves and educate and possibly provide a road map for those that support teachers. What concerns me is that teachers, more than ever, are being asked to teach in ways that they have not experienced, particularly where technology is concerned. Can we really give what we do not have? Which is why I believe it is so important to share these stories of experience. So I really thank you for taking this time to talk to me about of yours!

Teaching is complicated; perhaps because of this, as teachers we have an amazing ability to transform plans, programs, teaching style, and even the lay-out of our classrooms to fit any particular student's needs--just in the moment it is required. We also develop personal **philosophies and theories** of our own about what works and what doesn't with our own students. To begin, can you describe your:

1. **Philosophy of Learning**

- Help me understand in general your philosophy of learning. What works and what does not for your students? Can you describe (paint me a picture) what you think real learning looks like or sounds like with your class?

I believe the primary goal in any classroom is to engage students in meaningful learning. In the inquiry process learning is often a messy process. The process is not really a linear check-off list.

- How would you recognize meaningful learning as your students' work? In their behaviour?
- What elements are you looking for in your students work? The finished product?
- What do you think your students will need to be good at in the future?

2. **Philosophy of Technology**

Technology is any tool that extends human capacity. But as a tool it is more than just a device; it is also the technique of using it (skill) and the environment in which it is used. Technology only supports learning when it fulfills a learning need.

- What do you want from technology generally in your classroom? What human capacity (activity) do you need it to serve in your classroom?
- What collection of tools (high and low tech) have you used for these purposes over time?

Students learn, of course, from thinking not from the technology itself.

- How do you evaluate technology's meaningful impact on your particular students' learning?
- How do you know? What are you looking for?
- What supports have you encountered with using technology in your classroom in general? Who do you call?

3. **Innovation**

What you are doing with The iPad Project is innovation. The iPad is like no other device in your classroom. The Alberta Government says that creativity and innovation are central to achieving excellence in education. Yet many teachers describe **frustrations** when trying to incorporate a new tool (such as your iPad) into their classroom setting. Please help me understand your frustrations. Is it the device, the skill required, or the environment that puts the pressure on your comfort with innovation?

- How much of your frustration do you think is coming from the device on its own?
- What about finding apps to meet your personal needs? Do you have what you need?
- Can you add them yourself?
- How much frustration has come from adapting the iPad to do what you have done in the past with other technology (laptops, cameras)? What does it do or not do differently?
- How has the current network in your school (environment) supported or interfered with the things you need to do with the iPad?
- Can you describe how your students are using the iPad? What apps for what purpose?
- How easily are students able to gather information on the iPad and save on the network?
- How easy is it for students to share the device and collaborate on activities?
- Can you describe the connectivity issues with the network?
- When you encounter frustration with learning the tool, who are you able to call on for help? How long does it take?
- Can you describe how you feel at this point in the year compared to last year?

Finally, to be successful in my doctoral work, which means to be able to collect enough of the right kind of data to tell a story of experience, I need to be able to spend time with teachers in their classrooms as a participant, not just as an observer. Could you share with me some of your concerns that you had about me doing this so that I can learn and adjust?

APPENDIX B: CODED THEMES FINAL VERSION MAY 2012

Theme One: The Architect Role and Responsibilities:

1. Personalized Learning
   - Student Voice
   - Active Learning
   - Self-discovery
   - Flexible Learning
   - Responsive feedback
2. Collaborative Citizenship
   - Collaborative activities
   - Shared authority
3. Life Long Learners
   - Self directed
   - Student leadership
   - Responsible choices
   - Self-assessment
4. Multiple Literacy
   - Opportunity to read and express in a variety of contexts
5. Technology as partner
   - Cultivate creative thinking and action
   - Supports assessment
   - Supports knowledge construction
   - Easily accessible
6. Critical thinking
   - Opportunities to think deeply
   - Make judgments
   - Reflect

Theme Two: Enablers for Making Sense of Unfamiliar Technology

1. Teacher Capacity:
   - Comfort, Flexibility Personal Sense of Agency – A Questing Disposition (sees themselves as a learner)
   - Teacher Skill with Technology
   - Teacher Experience
2. Affordances from School:
   - Personal Professional Freedom
   - Reflective Culture of Learning – Collaborative Learning Environment
3. Affordances from the school District
   - Weekly IT support
   - Available Resource of Innovative Technology (iPads, doc cameras, SMARTboards)

- Accessible Professional Development (e-PD, AISI)

Theme Three: Inhibitors for Managing Unfamiliar Technology

1. Limitations of time and energy
   - Administrative time.
   - Meeting time.
   - Teacher evaluation.
2. Infrastructure
   - Filters on internet use and Connectivity to network
   - Computer Admin Privileges
3. Teacher Learning
   - Prescribed Professional Development or 'non-negotiable' PLC
   - Time to explore unfamiliar technology
   - The tone of change.
4. Remnants of historical conception of school:
   - Parents wanting children to have a similar learning experience to their own
   - Technology is an instrument to deliver content and for knowledge acquisition
   - Traditional instruction Teacher is the authority