

**Striving towards an understanding of experienced teachers' perceptions of the usefulness,
ease of use and effective integration of technology in their classroom**

Kieran Faw

A thesis submitted to the
Faculty of Graduate and Postdoctoral Studies
in partial fulfillment of the requirements for the
Master of Arts in Education

Faculty of Graduate and Postdoctoral Studies
Faculty of Education
University of Ottawa

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Abstract

Striving towards an understanding of experienced teachers' perceptions of the usefulness and effective integration of technology in their classroom

Key words: narrative theory, teachers, perceptions, technology, integration, limits, strategies, resources, perceived usefulness, perceived ease of use.

This thesis uses Narrative Theory and Technology Acceptance Model to uncover the experiences, perceptions, and challenges that five experienced teachers face when using and integrating technology in their classroom. It gives narrative consideration of the value of unique experience by focusing on the stories of each participant, and it analyzes narrative themes. This study found that there were numerous impacts on teachers' perceptions on the usefulness and ease of use of technology: this included (a) Limits: technology limits, teacher limits, student limits, and practical limits; (b) Support: school board, resources, equipment, parents; and (c) Dynamic environment (teacher-student feedback loop) which influence strategies for integrating technology: attitude, teaching orientation, classroom management, technology management, technology tools, and participant-observer strategies. Study limitations and recommendations are discussed.



Figure 1: Evolution of the Desk

Acknowledgement

I would like to thank my committee members who have shown patience throughout this entire process. A special thank you to Dr. Louis Trudel, my thesis advisor, who has been more than generous with his time and expertise. Thank you for the countless hours spent reflecting, encouraging, reading, mentoring, and teaching me this process. Thank you to Dr. Douglas Fleming, Dr. Giuliano Reis, and Dr. Louis Trudel for agreeing to serve on my committee.

I would like to acknowledge and thank the school board for allowing me to conduct my research with their teachers. A special thank you to all of my participants for sharing their wisdom, their struggles, their passion, and their vision for the success of technology integration into the classroom.

I want to thank you for this learning opportunity and for the personal and professional growth that this process has given me.

Dedication

I dedicate my Master's Thesis to my family. A special feeling of love and appreciation for my husband Jérôme for his patience and hard work supporting our small family while I completed this lengthy process. A special feeling of gratitude to my aunt Jane Hook whose words of encouragement and motivation helped me to complete this work. Thank you for your countless hours of editing assistance and keeping me accountable to the timelines set for this project. A special feeling of hope that my children will have every opportunity throughout their educational journey to learn, explore, and find balance in the new world they are entering.

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List of Acronyms and Abbreviations

3D	3-Dimensions
DVD	A type of compact disc able to store large amounts of data
IB	International Baccalaureate
ICT	Information and Communication Technology
IEPs	Individual Education Plans
IT	Interactive Technology
GTU	General Technology Usage questionnaire
LTO	Long-Term Occasional teacher
MP3	A file in MP3 format, small amounts of data
NDP	New Democratic Party
OT	Occasional Teacher
PC	Personal Computer
PD	Professional Development
PEU	Perceived Ease of Use
PhEt	PhEt Interactive Simulations, University of Colorado
PU	Perceived Usefulness
QR	Quick Response code
SHSM	Specialist High Skills Major
STSE	Science, Technology, Society, and the Environment
TAM	Technology Acceptance Model
Tech.	Technology
Tech-PLC	Technology Professional Learning Communities
TPB	Theory of Planned Behavior
TRA	Theory of Reasoned Action
VHS	Video Home System
Wikis	A website that allows collaborative editing of its content and structure by its users

Chapter 1: Introduction

Technology, it is everywhere. One of the last bastions of our traditional ways may be the reality that you are holding in your hands – an 8 x 11 x 1–inch thick stack of bound papers at a weight of 4.9 lbs (1543 grams), which is the tangible culmination of years of thesis work. It is a satisfying weight, but an expedient and fluid (if not ephemeral) knowledge exchange through technology is the wave of the future.

Did you notice the Quick Response (QR) code on the third page of this thesis? Were you able to scan it? In an instant you would have been transported to a remarkable video entitled the Evolution of the Desk¹ illustrating how technology has transformed the simple work space of the desk by removing all standard (old school) work implements. This video also makes obvious our dependency on technology and its increasingly important and productive role in society. Technology has enabled me to share this fascinating short video with you.

With new technology innovations arriving on the market almost daily, students and educators have instant access to endless information and content from the leading experts in almost *any field* from *anywhere* around the world at *any time* from almost *any device*. Mobile devices, such as smartphones, iPads and other tablets, allow access to a multitude of resources at the click of a button. The possible applications of this new and mobile technology in education and the classroom offers great potential. To ensure successful usage, we must thoroughly prepare teachers and give consideration to their perceptions about the usefulness and effectiveness of technological applications in the teaching and learning environment. Throughout the remainder of this paper, mobile technology and technology applications are interchangeable terms. Mobile

¹If you were unable to scan the QR code, please find the video here:
<http://img.ibxk.com.br/2014/09/23/23120354214264.gif>

technology such as cellular phones, tablets, mp3 players, etc. are a form of technology application that can be used by teachers in their efforts to integrate technology into their classrooms.

The introduction of this paper outlines the following sections: Brief Overview of the Research, my Researcher's Narrative, and Organization of the Thesis. The Researcher's Narrative section has been included in order to introduce myself as a person and a professional teacher with an interest in science. This section also gives credibility to my choice of method while at the same time explicitly stating biases or conflicts of interest.

Brief Overview of Thesis Research

The purpose of this thesis is to uncover how experienced teachers perceive the use technology in their classroom practices by exploring their views towards technology acceptance and usage. This study was conducted in a single school board in a large city in Eastern Ontario in both semestered and non-semestered schools. An explanatory sequential mixed method approach as proposed by Ivankova, Creswell, and Stick (2006) was taken using Davis' (1989) Technology Acceptance Model and the primary methods of inquiry of Narrative Theory (Polkinghorne, 2007; Bruner, 1990) within the paradigm of Phenomenology. After a search of all secondary school profiles, a *General Technology Usage* questionnaire was developed and delivered to over 230 teachers listed as teaching Science on their school profile. An 8.7 percent rate of return (20 questionnaires) uncovered both demographic and informative responses that illustrated an initial impression of the participant group. Questionnaire data was analyzed to narrow the participant group to teachers who used technology five-hours or more weekly in their

classrooms. More details on the reasoning behind the required minimum of five-hours per week of technology usage can be found in the Methodology chapter. The five willing participants took part in a three-stage interview process with questions becoming increasingly focused throughout each interview to obtain substantial and valuable data. Interview participants came from five different schools, had different levels of teaching and technology experience, held different roles within their schools, and taught different leveled science courses ranging from locally developed to international baccalaureate programs. Through the course of this thesis, a story of technology and its implementation, constraints, and support requirements emerged. Technology was seen as a helpful tool, and participants were optimistic, yet also experienced technology as problematic with glitches and difficulties. All of the participants identified as science teachers; their pedagogy and curriculum requirements were varied and each was truly unique in their perceptions of technology usage. Despite their differences, they all shared a common goal of integrating technology into their teaching and learning environments to benefit their students.

The Findings have been divided into two chapters presenting, firstly the quantitative findings and participant narratives, and lastly an analysis of the qualitative themes. I believe that although each section has a different focus, separately or together, they provided a rich picture of the participants' shared stories using technology within their classroom. This study sheds light on the possible factors influencing how teachers interact with, use, and ultimately accept technology into their teaching practices through the narratives of the participants.

While there is an ongoing march towards technology integration and many applications available, student perceptions have been a focus of research. As I outline below, there remains a limited research in the literature in our understanding of teachers' perceptions of technology. Teachers are conduits for teaching students and there is little known about their use of

technology in the classroom or their attitudes towards it. This study fills this void.

Researcher's Narrative

It is important, I feel, to introduce myself at the outset of this thesis. My thesis focuses on personal and professional perceptions and experiences. It seems prudent that my personal narrative be included so that the reader might understand my perceptions and experiences as well as how these have influenced my interest in the topic and my approach to this thesis.

I grew up in the technological boom of the late 1980s and 1990s. I have been a student and hold two degrees, one in Science and one in Education. I am a science teacher (with a background in Physics and Biology), and am relatively new to this profession. Despite growing up with technology and being fascinated by its opportunities, I am also overwhelmed by it. I view technology in education as inevitable. While I have used technology as an immense aid in my teaching, I have also experienced the pressure of not knowing enough and feeling the stresses of trying to stay current so I can be of benefit to my students. Through my experiences as a student and into the development of my teaching strategies, I began to wonder how teachers or school boards could be expected to understand the multidimensional, multi-faceted, multi-user nature of technology in order to fulfill the needs of many and incorporate new technology into their teaching and learning environments. This curiosity, in part, has led to this study.

I believe it is important to identify my personal bias or expectations for this research. Upon graduation in 2009, I was immediately hired as an Occasional Teacher (OT) in the same school district where I did my practicum training and where this research study took place. More recently, I was interviewed and hired as a Long-Term Occasional (LTO) teacher. This is the usual way for beginning teachers to “get their foot in the door” as many school districts only hire

directly from their OT or LTO lists.

Although my experience in the classroom is limited to daily supply teaching during the regular school year and teaching summer and night school, I have managed to use and integrate different forms of technology into my teaching. In addition to using PowerPoint, Smartboards and overhead projectors, I also have experience integrating Wikis, blogs, and social media platforms such as NING and Schoology into my teaching routine. Having this experience, I understood and experienced similar frustrations to those of the participants while at the same time being surprised and enlightened by their determination and resiliency to overcome their perceived limitations.

My specific function within this research study is multifaceted. This is my master's degree thesis. I am the student learner. I am the project designer. I am the literature reader. I am the schedule maker. I am the interview reporter. I am the interview transcriber. I am the theme decoder. I am the thesis writer. All of these roles are executed with varying degrees of skill and with the need of help and guidance; just as with all of us, my role is a mixture of ability, learning, and evolution. This thesis has allowed me to grow and develop not only my skills as a researcher but also expand my understanding of the endless possibilities and opportunities technology opens for teachers and students.

Organization of Thesis

This study has been organized into eight chapters: 1. Introduction; 2. Literature Review; 3. Research Purpose and Question; 4. Theoretical and Conceptual Frameworks; 5. Methodology; 6. Findings; 7. Analysis; 8. Discussion; and 9. Conclusion and Summary. Chapter 6 has been divided into two parts; A: quantitative data obtained from the General Technology Usage (GTU)

questionnaire describing the demographic themes of the data; B: qualitative narratives of participants' shared stories through their voice. Chapter 7 provides analysis of the qualitative themes obtained from the richness of the shared stories of the participants and has been organized to answer the three secondary research questions of this study. The discussion chapter positions the thesis findings within the current field of research. The conclusion of this thesis states the implications and limitations of the thesis, future research recommendations and expansion possibilities of this thesis for the local school board. This thesis finally concludes with the recommendations of the participants and my reflection as a researcher. More contextual information will be provided in the methodology chapter.

Chapter 2: Literature Review

A search of the University of Ottawa Library homepage was the starting point for the process of reviewing the current literature in this field. An exploration of the ERIC, SAGE Research Methods, and Scholars Portal Journals databases was conducted by using a keyword search including, but not limited, to the following words: technology integration, teacher perception, attitude, technology usage, classroom tools, and technology applications. Popular Journals in this field of research are the: Computers and Education; Computers in Human Behavior; Education Technology, Research, and Development; Educational Technology and Society; Human Technology; Journal of Research on Technology Education; Journal of Teaching and Learning; Journal of Technology and Teacher Education; MIS Quarterly; and Research in Science and Technological Education. The above journals were investigated using my criteria. As well, a study of the literature review and reference sections within relevant articles also served as a basis for further examination. I compiled a list of supporting articles and reviewed any pertinent article which seemed to have relevance to my inquiry.

This review is divided into three sections: I) teachers' beliefs, attitudes and perceptions, II) technology integration, III) integration close to home. This chapter concludes by identifying the research problem to be investigated.

As I describe in this chapter, evidence shows that technology supports diversity among learners, active engagement, participation in groups, and frequent interaction and feedback, as well as providing supportive environments for both teachers and students, connection to real world experts, improved test scores, and engagement of students with lower attention spans. Current literature has shown that technology can be used to encourage homework, saves money,

and can be used as a teaching tool, making the lives of the teachers easier through the ease of: changing and amending lesson plans quickly, finding information, sending information to multiple users simultaneously, instant communication, and the WOW factor for keeping students engaged (Vedanthan & Breeden, 1995; Edutopia, 2008; Roblyer and Doering, 2009; van den Beemt, 2010; van den Beemt, 2011; Rosen, 2011; Thomas and Orthober, 2011; Zucker, 2012; Glass and Licitra, 2012).

In addition, Kolb (2011) argues that a basic cell phone can be the Swiss army knife of digital learning tools and they should not be banned from the learning environment. Even though studies have shown that students enjoy interacting with technology, teachers have varying perceptions, values, and intentions when it comes to the real-time application of technology in the classroom and there is a need to understand why.

Teacher Beliefs, Attitudes and Perceptions

There are many variables that can influence teacher's perceptions. For instances, Martinovic, Magliaro and Pugh (2011) found that teachers beliefs and attitude towards technology use and integration range in focus, including: a general lack of technology integration, beliefs as influencing behaviour, successful integration as determined by willingness or unwillingness to use technology, differentiated ideas about the purpose and usefulness of technology as it relates to attitudes and successful integration, the impacts of proper support on beliefs, technology integration and its connection to beliefs about education generally, and how active decisions to integrate can influence attitudes through the active discovery of technology's usefulness. As such, findings by Martinovic (2011) emphasized that with the collaboration through conversations of educational researchers, it is possible to reach a deeper understanding of the

events that influence the teacher's experience with technology. Regrettably, the research field is still striving to understand teachers' individual attitudes and personal beliefs in relation to the *lack* of usage of technology in the classroom (Sugar, Crawley and Fine, 2004; Turvey, 2012). Thus, it is important to understand the beliefs of educators because they may be influential in bringing about changes that are beyond the direct control of Ministries of Education (Pelgrum, 2001, pg. 164). In the classroom, teachers may have more choice over what tools they use to deliver their content or how they collect each assessment.

Teo (2009) argues that autonomy can greatly influence an individual's perception and can easily impact their behavior. For instance, Teo (2009) reported that educational technology users (teachers) possess greater autonomy over their choices involving the use of technologies in comparison to general users. Research conducted by Sugar (2004) and Teo, Lee and Chai, (2008), found that the successful use of computers in education depends largely on the attitudes of teachers towards technology adoption and their willingness to embrace the technology. Also, beliefs about the purpose of technology can have a strong influence regarding the success of integration (Pedersen & Marck, 2007). Studies on teachers' perceptions of technology and its integration have an implicit focus on technology usefulness, student benefit, and teacher fear. In spite of this, Schmidt and Callahan (1992) stated that with proper support, we can begin to conquer the fear that technology will harm the students' understanding of basic skills and push them to become overly dependent on technology. In fact, Guerrero, Walker, and Dugdale, (2004) noted that there is a need to help teachers transform their attitudes towards technology from "apprehensive" to "mainly enthusiastic". Indeed, Ertmert, Ottenbriet-Leftwich, Sadik, Sendurur and Sendurur (2012) found that it was the teacher's own beliefs and attitudes about the relevance of technology to students' learning that were perceived to have the biggest impact on its

successful integration into classroom practices. As well, researchers Garthwait and Weller (2005) and Kim, Grabowski and Song (2003), claimed that a teacher's level of integration of technology was strongly related to their educational beliefs about teaching and learning, student achievement, pedagogy, and the role of technology in the classroom.

Teachers' beliefs and perceptions of the usefulness and ease of use of technology have significant influences, both positive and negative, when it comes to actual usage. For example, researchers Li (2007) and Yuen and Ma (2002) found that a teacher's positive or negative views on the usefulness of technology in the classroom directly influence their motivation to integrate it into their curriculum. Accordingly, we must wonder if those teachers who perceive technology to be less useful, limit the opportunities for technology interaction to their students. Understanding and educating teachers on the usefulness and ease of technology in all domains of education could help to encourage teachers to consider using technology in the classroom. Interestingly, in Sugar (2004), technology adoption decisions were found to influence teachers' individual attitudes towards adoption which were formed in tandem with specific underlying personal beliefs about the perceived consequences. They found that teachers use technology because it motivates students and offers differentiated learning opportunities.

In conclusion, research to date on teachers' beliefs, attitudes and perceptions vis-à-vis technology use and integration focuses on the impact of beliefs on teachers' behaviour and how proper support and positive decisions can have a bearing on integration, teachers' increased skill, and an adaptive embracing of technology which helps students. After a search of the literature, this research has not uncovered a minority view.

Technology Integration

The trek to understanding technology integration has been a lengthy journey. There are two main areas of research when it comes to understanding technology integration: teacher-focused research and student-focused research.

Research on teachers' attempts (or lack thereof) to integrate technology fall into general themes related to barriers and skill base. Rose (2000) also reminds us that there is a "technological time-lag" (pp. 580) between discovery and application. This time-lag can be due to financial constraints as well as issues of feeling overwhelmed due to lack of time, unclear goals, limited understanding or struggles with aspects of conceptualizing technology, and practical skill limits including lack of knowing how to use the tools effectively and efficiently. In a study reflecting on teacher development and technology education, Compton and Jones (1998) focused on the differences between those who adopt technology versus those who don't, finding that those with skills feel no pressure and are persistent and those who lack skill feel tremendous pressure and abandon their efforts prematurely. Integration research is more fully explored, below.

After the integration of the computer into the business and home environments, schools were next to adopt the technology. As pointed out by Kiraz and Ozdemir, the existence of technology does not guarantee its utilization in the classroom environment. In the 1990s, schools were expected to equip learners with the basic technological skills, such as typing, required by society (Mentz & Mentz, 2003). Yet, even though teaching without technology appeared impossible, for some individuals or in certain situations, technologies were seen as either a liberating tool or an oppressive obligation (Bruce & Hogen, 1998).

Each teacher, student, and classroom faces their own obstacles when interacting with new technologies. Teachers have a multitude of tasks outside the classroom, including but not limited to planning lessons, grading, meeting with parents, and administrative tasks. For many teachers the idea of adding one more thing to an already full curriculum may seem overwhelming and virtually impossible (Larson, 2010).

Lim and Khine (2006) found that the use of computers remains minimal and peripheral in the classroom because teachers are not using technology effectively. Additionally, Brown, Alford, Rollins, Stillisano and Waxman (2012) observed that just knowing how to use technology is not sufficient. They found that teachers need knowledge on how to use technology in their instruction and to feel confident in their ability when using technology. Curban (2001) also suggested that what affects the way some teachers integrate technologies into their pedagogical practices is far more complex than a straightforward causal relationship between their professional use of technology and how they make use of such technology in their wider social and leisure lives. With the latest technology boom, teachers have been exposed to technology in their everyday lives and to the idea of teaching with technology; however, Kiraz and Ozdemir (2006) found that the “existence of technology does not guarantee its utilization in the classroom environment” (pg. 152).

Teachers have a large impact on how technology is being integrated in the schools. When teachers feel they are skilled at using technology in their teaching and learning practices, they experience less external pressures to integrate it quickly (Kreijns, 2013). Kreijns (2013) also found the opposite phenomenon: teachers who feel they lack sufficient ICT (information communication technology) skills experience more external pressures, because the behaviour they are expected to show is less evident. Interestingly, a recent study by Aldunate and

Nussbaum (2013) found that teachers who are early adopters of technology and make the necessary time commitment to incorporate technology into their teaching are more likely to adopt new technology regardless of its complexity. Conversely, their study also found that teachers who only committed a small amount of their time were less likely to adopt new technology and were prone to abandon its adoption completely. Similar findings were noted with regard to the subject of technology education. Chikasanda (2013) found that teachers with limited understanding of the phenomenon of technology education struggle to conceptualize the learning area, and research by Ginns, Norton, McRobbie, and Davis (2007) suggested that this kind of struggle poses an impediment on the implementation of technology as a school subject. In other words, teachers need to understand the conceptual underpinning of a subject to successfully teach that subject. In trying to understand these integration pressures, Ertmer and Ottenbreit-Leftwich (2010) found that the important first step to effective use technology in the classroom is to have knowledge of the technology itself.

In the eyes of some educators, technology may be seen as advancing too rapidly and as transforming the society and culture surrounding education far faster than they can sustain (Bauer & Kenton, 2005). Because of this, they suggested that schools have not yet achieved true technology integration. They define integration as “a reliance on computer technology for regular lesson delivery” and propose that for true integration to occur “teachers consciously decide to designate certain tasks and responsibilities to technology” (pg. 522). In a similar vein, one participant in Garthwait and Weller (2005) study views the use of technology as a means of performing traditional work more efficiently with the goal not to transform the nature of educational roles but to deliver material more effectively. With this in mind, they suggest that “change takes times and deep change may take longer, but major shifts are unlikely without the

simultaneous efforts of teachers to understand and to share belief in transformational goals” (pg. 374). Reviewing these findings in 2016, these sentiments remain relevant.

Integration Close to Home

Technology has changed day-to-day lives of every citizen. Here in Ontario, the Ministry of Education is taking steps to address this change in our society. Pelgrum (2001) identified that since the late 1990s, many governments developed plans to intensify their investment regarding information and communication technology in education. Today, in 2016, technology integration remains a focus and with each new revision of the Ontario science curriculum, a modernized technology curriculum is finding its place in teaching and learning outcomes. Throughout the curriculum, emphasis on the importance of scientific, technological, and environmental literacy for all students is a growing priority (Education, 2008).

Proficiency in technology is paramount for today’s students and many schools and districts are trying to figure out how they can leverage, rather than disallow, devices already owned by students as tools in the classroom (Scherer, 2011). Keeping in line with this trend, the school board involved in this research study is taking its first steps and preparing an action plan for the integration of mobile technology into the classroom. In their report, the school board outlines their goal as having a fully mobile and user-accessible technology environment by 2017. This report also states that technology has a considerable impact on classroom practices and on our ability to further engage students through the development of rich learning tasks which emphasize collaboration, creativity, and critical thinking. The report, however, also identified a need to answer concerns about how schools can increase the integration of Interactive Technology (IT) into teaching and learning, including concerns over the rate of technology

acceptance. This report illustrated the need in the local education community to thoroughly understand the beliefs and views of its teachers to move forward in this new spectrum of teaching and learning opportunities. Due to confidentiality concerns of study participants, referencing of this report cannot be provided.

By examining and uncovering the use of technology integration through the shared stories of local teachers' perceptions, we can begin to identify and propose strategies for how schools within this board and other educational communities can increase the integration of new technologies into teaching and learning.

In brief, there is a need to understand the perceptions of teachers possible so that we can then begin to fully understand the strategies for effective integration. As learned from this literature review, the following statements are true: teachers teach students; students are natural and prolific users of technology; technology is ever advancing; technology is not used within the teaching environment (the classroom) in an integrated way; some teachers use technology more than others. Questions remain however, about how we get all teachers to use technology and what barriers slow the integration of technology. And if it is in students' best interests, exactly what steps should be taken to ensure a positive impact on student and teacher? In understanding the perceptions and experiences of those teachers who currently use technology within their classroom, some answers to these questions may emerge.

Research Problem

After a review of the literature, it appears that there has been much research conducted on the integration of technology, however, there are few research studies that have undertaken the task of trying to understand from the point of view of teachers how they perceive this integration.

This thesis addresses this issue. It is important to learn more about the way their backgrounds, the way they teach, and all the details about how they use technology from the point of view of the teachers, so that we can have successful integration. There were also few studies found that has focused specifically on science teachers and their perceptions of using technology in the classroom and this study has been designed to attempt to fill this gap.

Just as society advances through the use of new technology, so too will the landscape of education changes (and will continue to change) with the advancement of technology. Technology has so permeated society, it is hard to believe that less than a decade ago technologies like Smartphones and tablets barely existed (Ito, 2008). As technology continues to become increasingly universal, powerful, and adaptable, so does how and what we teach in the classroom (Levin & Wadmany, 2008). There are implications to integrating technology in schools and struggles along the way. It is useful to understand the ever-evolving process so that proactive decisions are made for the benefit of teaching future students. By studying how teachers perceive the usefulness and ease of use of technology, we can begin to understand the factors that impact its integration into the classroom and avoid potential problems of integration.

Chapter 3: Research Purpose and Question

Objective

The objective of this thesis is to shed light on how teachers perceive the usefulness, ease of use and effective integration of technology as a teaching and learning tool in their classrooms. Since perceptions are complex, vary from person to person, and are influenced by the individuals' experiences, it is important to understand how teachers' experiences, or lack of experiences, with technology influence their perceptions in the first-person. The main goal of this thesis is to uncover the experiences, perceptions and challenges of participants when using and integrating technology into the classroom. The following are subsumed under this goal:

- Participant' perception of the usefulness and ease of use of technology
- The process that participants go through when integrating technology
- Participants' beliefs about the value and effectiveness of technological application in the classroom
- Participants' views on technology acceptance and usage
- The factors that influence participants' interaction with, use and acceptance of technology

Justification

After reviewing the academic literature and the policies and action plans of the local school board involved, and of which the participants are members, technology integration concerns were shown to be a viable focus of this study. More specifically, by investigating teachers within the same school board, and their perceptions of the usefulness and ease of use of technology, and

how these perceptions influence how technology is accepted and integrated, much could be learned that could be translated into practical policy and learning initiatives. Such initiatives would benefit the daily lives of teachers as they integrate technology into their classrooms.

Students may fully, and maybe sometimes indiscriminately, adopted technology into their everyday lives because they have grown up with technology all around them. Students see new media as providing them with the desired freedom and autonomy that is less apparent in traditional classrooms (Ito, 2008). Technology is entrenched so deeply into the daily lives of students that, beyond the walls of their schools, are blogging, acting as citizen journalists, and posting stories to different media platforms designed for creating new avenues for the sharing of content (Squire, 2009; Ito, 2010).

Some teachers, on the other hand, may not be as quick to adopt technology. Through conversations with colleagues during my contracts as an occasional teacher and night school teacher, I started to understand that everyone incorporates technology into unique ways that are personalized to their teaching philosophy. This is supported by Levin and Wadmany (2008) who viewed teachers as the key players in changing the educational world. The successful use of computers in learning depends greatly on the attitudes of teachers and their readiness to embrace technology (Teo, et al., 2008). The acceptance and integration of technology is not something that happens quickly nor without extensive examination by policy makers, administrators, teachers, and parents. More recently, teachers who are regarded as leaders in their subject disciplines, can be seen as having less knowledge of and exposure to new technology if they are not using technology and that their students are seen as the new experts and are more technologically experienced (Amichai-Hamburger, 2013). In addition to this, there are many external factors that influence how and why a teacher may choose to use technology in their

classroom (Niess, 2005). Among them, the teachers' perception of the process of integration may be the most important and may determine whether he or she will take the actions necessary to learn how to use technology, relate the technology to their content, design lessons that effectively use the technology, and then actually teach with the technology (Gray, 1997). As we will see through this thesis, this appears to remain true of this sample of teachers in 2016.

Walsh and Vannatta (2001) described technology infusion as "a multifaceted process that takes time, support, and collaboration" (pg.124). To avoid the pitfalls of implementing an action plan for the integration of technology in the classroom that is not based on practical experiences, we must first aim to have a fuller appreciation for how teachers perceive the usefulness and ease of use of technology and their level of acceptance. Teaching is a personal and individualized profession. All teachers are different; teachers have different personalities, teaching methods, areas of expertise, and ways of relating to their students. From teaching strategies and styles, to methods of delivery of educational content, teachers will have differing ideas about quality, quantity, and technique when it comes to integrating new technology into the classroom. Technological advances are not going away and it is our responsibility as educational professionals to find a way to integrate these tools to fit our personalized teaching styles.

In my opinion, we can no longer keep new technology out of our schools. Students are coming with their own devices. We must embrace new technology, work together to build effective strategies, and communicate and collaborate with colleagues, parents, and even students to fully understand and make the most of this changing teaching and learning environment.

With the ways in which current technology is transforming education through different methods of retrieval and presentation to opportunities for collaboration and at the rate new technologies are advancing, there is a push in education to form and maintain professional

learning communities where individuals can share like ideas and collaborate on course materials (Kreijns, 2013; MacDonald, 2008; Roschelle, 2002; Scherer, 2011). Teachers have an impact on their students' perceptions and beliefs of technology and also on those of their colleagues and administration. I tend to agree with research conducted by Kaasinen (2005), that having a supportive environment where educators can communicate openly, share ideas, beliefs, views, and concerns, especially around the task of integrating technology into the classroom, can help to develop and shift teachers' perceptions from an initial tolerance of technology (based on the opinions of colleagues and the administration) to a fluent, long-lasting acceptance of technology built with the support of professional learning communities. This thesis will focus on developing a better understanding of the perceptions that teachers have towards incorporating technology into their teaching and learning environments.

Research Question

This research thesis is centered on the following leading research question:

How does a purposeful sample of experienced public school secondary teachers perceive the usefulness, ease of use and effective integration of technology in their classrooms?

To understand and more fully delve into teachers' experiences, the following three secondary research questions were developed.

1. What specific limitations or constraints do these teachers perceive as affecting their attempts effectively to incorporate technology into their classrooms?
2. What specific teaching strategies do these teachers perceive as being useful in the effective

incorporation of technology into their teaching?

3. What specific supports do teachers perceive as being necessary for the effective incorporation of technology into their teaching?

Study Purpose

By capturing the shared stories of teachers, this research will provide enriched and multidimensional data to the educational technology research field and its studies as described in the next chapter. A clearer understanding of the uses, barriers, and opportunities for technology usage in the classroom was developed, as well as a deeper meaning to the unique experience of daily life for experienced teachers who are integrating technology. The research findings herein are specific enough to be of benefit to the school boards, policy makers, principals, and teachers of all disciplines who are wanting to find the best ways to integrate technology into the classroom.

Chapter 4: Theoretical Frameworks and Conceptual Framework

Theoretical Frameworks

There are many types of academic theories and paradigms in the field of education that resemble each other despite emanating from different disciplines such as philosophy, psychology, and sociology for example. My working theoretical model centers on my interest in understanding an individual teachers' perceptions, thoughts and ideas about a subject matter; namely teachers thinking about technology usage. While teachers learn in collaboration, the focus of this thesis does not have the underpinnings of a Constructivist (Jean Piaget) or Social Constructivism theories Vygotsky's (1978), whose theories focus on understanding and learning emanating from within the dynamic between people. My thesis more so attempts to understand personal experience reflexively, through understanding their beliefs and perceptions. As such, the theoretical frameworks of Phenomenology align more closely with the intentions of this thesis.

I will briefly describe Phenomenology theory as an umbrella philosophical position and use this lens as the foundation of my analysis with narrative theory, which I believe is both a theoretical paradigm and a work methodology. As well, in this chapter, I will introduce Davis' (1989) Technology Acceptance Model and the key terms of use as my working knowledge defines them.

Phenomenology.

Phenomenology is the study of structures of consciousness as experienced from the first-person point of view. Since this thesis explored teacher's perception of technology, the use of the phenomenology paradigm allows for the exploration of phenomenon within the group of participants who experience technology in their classrooms. In regards to the philosophical assumptions of phenomenology, both van Manen (1990) and Moustakas (1994) agree that a person's experiences are conscious ones and focus on the development of the description of the essences of these experiences rather than explanations or analysis. This thesis also respects the lived experiences of participants and has captured the essences of their conscious experiences with the phenomenon of technology through using Narrative Theory. Although this thesis leans more heavily on the qualitative method, it is informed by the quantitative data collected through the technology acceptance model described below.

Technology Acceptance Model.

In this section, I will explore academic research models developed for understanding how technology is being used in education and focus on identifying the factors that influence the acceptance of technology amongst teachers.

Technology acceptance has been a topic of interest for the business world (Davis, 1989) since the entrance of the computer into everyday productivity. After a review of the literature, it appears the topic of technology acceptance in education is a much younger based on far fewer studies found. We cannot forget that the field of education and the perceptions of teachers, like in the field of business (Davis, 1989), are strongly influenced by the norms of their social

environments. As I note below, over the last 50 years of technology acceptance research, there has been an evolution of ideas. It appears that each theory takes and builds upon its predecessor.

The pioneering model of this field of research was the *Theory of Reasoned Action* (TRA) proposed by Ajzen and Fishbein (1975; 1980). According to this theory, a person's intention to perform a certain behavior is influenced by his attitude and the perceived attitudes of those around him, also known as the subjective or social norm (Vallerand & Bissonnette., 1992). As with many theories, this theory was revised into the *Theory of Planned Behavior* (TPB) (Ajzen, 1991). The central factor in both theories is the intention to perform a behavior. Ajzen (1991) claimed that "intentions are assumed to capture the motivational factors that influence behavior; they are indications of how hard people are willing to try, of how much of an effort they are planning to exert, in order to perform the behavior" (pg. 181). Both of these theories also state that the predictors for behavioral intention can only be found if the behavior in question is under one's own control (Sheppard, Hartwick & Warshaw, 1988; Ajzen, 1991).

Based on conversations I have had with colleagues, I tend to feel that as much as teachers would like to maintain that they have control over their choices within their classrooms, the truth is that a multitude of factors: media, school culture, school board, board of trustees, parents and students, and other external pressures, influence their attitude towards technology usage in the classroom.

In 1989, Fred Davis proposed the Technology Acceptance Model (TAM) to answer the question of why functioning information systems designed to increase performance were not being utilized and to explain the behavioral intentions of potential users. Davis' TAM is based on the Theory of Reasoned Action (TRA), a psychological theory that works to explain behavior based on one's intentions (Fishbein & Ajzen, 1975). The TAM states that two attitudes influence

the level of technology adoption by individuals: *Perceived Usefulness* and *Perceived Ease of Use*. Davis (1989) defined perceived usefulness (PU) as “the degree to which a person believes that using a particular system would enhance his or her job performance”, and defined perceived ease of use (PEU) as “the degree to which a person believes that using a particular system would be free of effort” (pg. 320). King and He (2008) conducted a statistical meta-analysis of the how the TAM was applied in various fields. They looked at 88 published studies and found that the TAM is a valid and robust model for conducting research. The usefulness of the TAM to the technology and educational research field to explain the acceptance of new technology is becoming realized. An interpretation of the evolution of the development of the TAM can be seen in Figure 3 below. As we move from the Theory of Reasoned Action towards the Theory of Planned Behaviour, we notice that the previous model’s Behavioural Intentions are replaced with the latter model’s Perceived Behavioural Control. As we move towards the Technology acceptance models, PU and PEU replace the Attitude measures of the models prior. Venkatesh and Davis (2000) began to account for the social influences as they relate to technology acceptance.

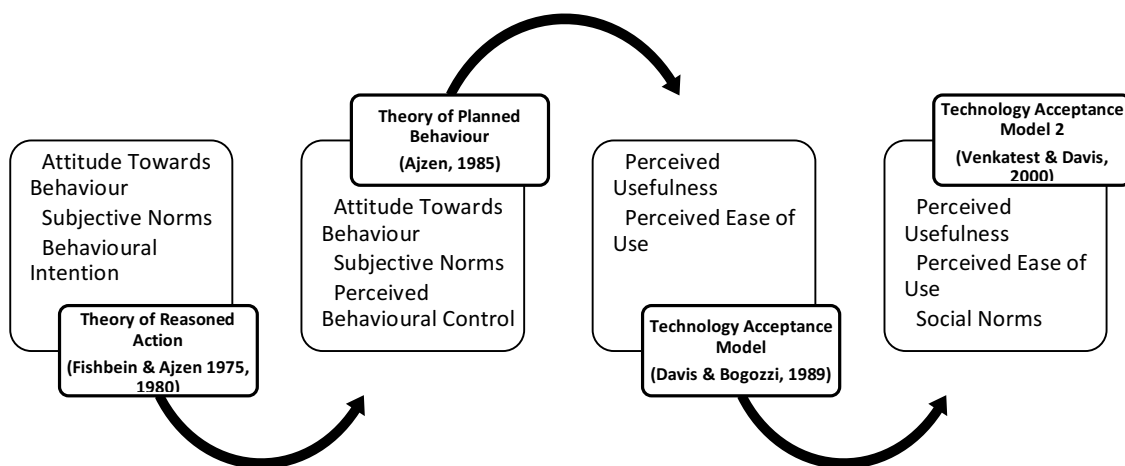


Figure 2: Evolution to the Development of the Technology Acceptance Model

As technology has advanced, definitions of PU and PEU have been refined. More recently, Rogers (2003) defined perceived usefulness as “the degree to which an innovation is perceived to be better than its precursor”; perceived ease of use has also been redefined as complex and the degree to which a system is perceived as relatively difficult to understand and use (Rogers, 2003; Thompson, Higgins & Howell, 1991). In the Mazman and Usluel (2010) study on modeling the educational usage of Facebook, perceived usefulness was defined as “the perception formed by the belief that using a particular system enhances individuals’ performance while claiming that this innovation is better than its precursors”, and defines perceived ease of use as “using (Facebook) features easily and managing the overall (Facebook) content without much effort” (pg. 445). With this in mind, studies have shown that a useful tool is a tool that performs as expected. It must first be perceived to be helpful to teaching practices and performance. If a teacher struggles using technology in the classroom and student learning is limited, the teacher

may be less likely to adopt technology into their teaching routine (Polly, Mims, Shepherd & Inan 2010; Robert & Ferris, 1994).

Any technology that is going to be accepted into their classroom needs to be perceived as requiring little or no effort to learn and master (Abbitt, 2011; Wang, Ertmer & Newby, 2004). Because teaching can be a very social and collaborative profession, working with colleagues to learn and master technology will save teachers time. In the case of technology in education, teachers (as well as students) feel the influence of their social environments in many aspects of their lives (ChanLin, Hong, Horng, Chang & Chu, 2006) and by extension, their decisions to adopt or not adopt a particular technology.

Lastly, teachers are generally more accepting of technology if they perceive there is a strong support system, such as colleagues, principals, or board members, in place to help them along the way (Almekhlafi & Almeqdadi, 2010; Stevenson, 2004; Szymanski & Morrel, 2008). These kinds of supports constitute some of the factors influencing the perceptions of teachers while they attempt to integrate technology.

Technology Acceptance Model Terms.

Below are the terms used for this thesis as I have defined them:

Perceived Usefulness: How technology can be used to improve one's day-to-day learning and teaching experience.

Perceived Ease of Use: How simple a technology is to use, so as to not add more stress, overwhelm or a longer learning curve.

Specific limitations or constraints to incorporating technology into classroom: Any difficulty experienced by a teacher (novice or expert) while using technology.

Specific teaching strategies or instructional methods used when using technology: (a) What approaches (behavioral, emotional, cognitive) teachers are using to incorporate technologies into the classroom; (b) How technology is affecting teaching methods; and (c) How technology is being used to support a teacher's pedagogical needs.

Specific supports to aid in incorporating technology into teaching: What resources, policies, training, or programs would help teachers make the transition to adopt or implement technology in a way that is long-term and sustainable.

Conceptual Framework

This study's purpose is to elucidate an understanding of how experienced teachers perceive the usefulness, ease of use and effective integration of technology use in their classroom. The conceptual framework illustrated in Figure 3 below, demonstrates the factors and variables explored in this thesis. Although, at the center of this thesis are the experiences of the technologically integrated science teachers, the experiences shared by the participants could be applied to other pedagogical disciplines. As explained above, perceptions and technology acceptance is a unique research field. Therefore, for the benefit of this thesis, both quantitative and qualitative methods provide the framework or lens through which to explore teacher perceptions. Due to the individual nature of perceptions, a mixed methods approach was necessary to fully understand participant's experiences.

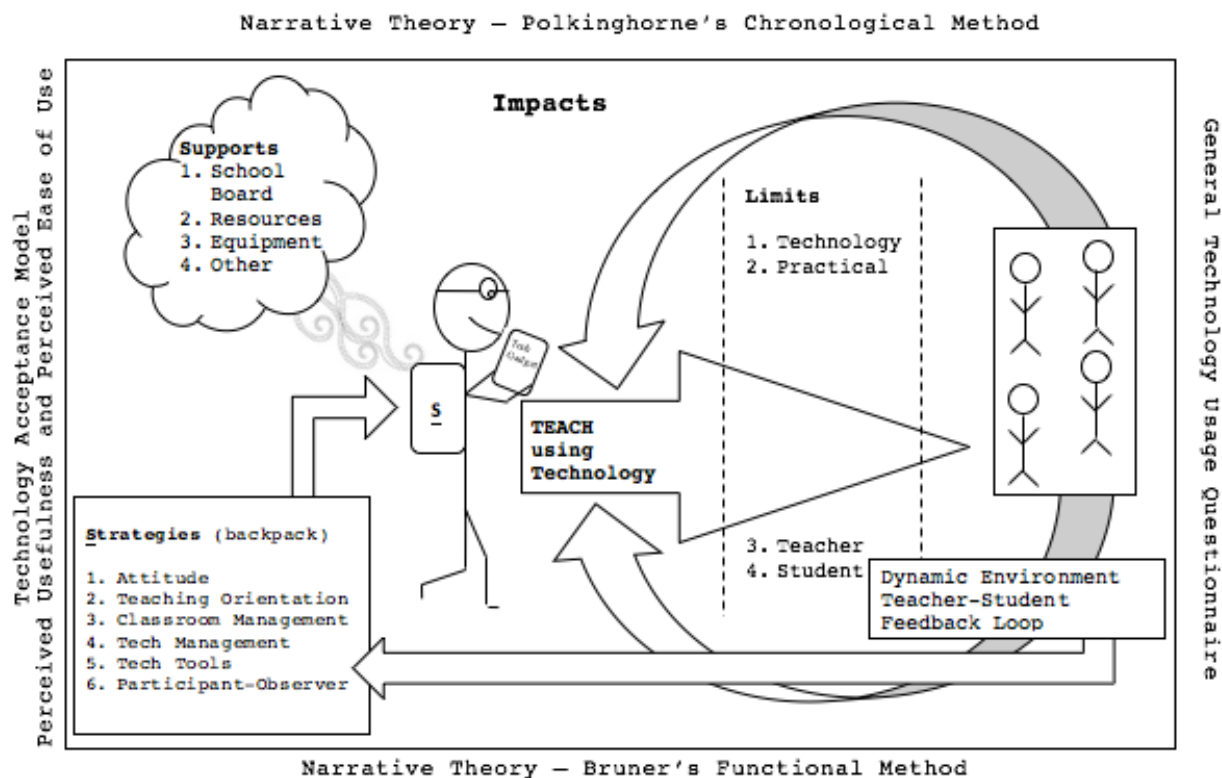


Figure 3: Conceptual Framework for Thesis

Using the Explanatory Sequential mixed methods design proposed by Ivankova, Creswell and Stick (2006), this thesis utilized quantitative research results to inform a more precise qualitative data collection strategy in order to grasp the rich and deep beliefs and perceptions of the teacher. This mixed methods design places priority more heavily on the qualitative methods of narrative theory. More details on the mixed methods approach, can be found in the next chapter.

The validated quantitative tool, the TAM model (Davis, 1989), was used to explore perceived usefulness and perceived ease of use of technology and served as the genesis for developing the General Technology Usage (GTU) questionnaire created specifically for this

thesis, which was then analyzed. The following steps were taken to validate the GTU questionnaire: (a) design assistance from thesis supervisor (b) it was based on previous research (Davis, 1989), and (c) critical evaluation of the tools for clarity and relevance of questions pertaining to this thesis. Narrative theory methods were used through the interview process with the five teachers. Their individual narratives were explored using Polkinghorne's Chronological Method of inquiry (Polkinghorne, 2007). An analysis of the narratives, as described in Chapter 8, seek to answer the secondary questions of this study by using Bruner's Functional Method of Inquiry (Bruner, 1990) to analyze the themes, contradictions, and paradoxes in order to better understand the commonalities experienced by the five teachers. For Bruner (1990), individuals do not make sense of the world around them through single events. Instead each individual event is added to and framed within a large structure of many events. Common and divergent experiences (including patterns, themes, regularities as well as contrasts, paradoxes, and irregularities) are analyzed to give a depth of understanding.

This conceptual model was developed through the framework of Bruner's Functional Method, Polkinghorne's Chronological Method, and Davis' Technology Acceptance Model and the developed quantitative tool the Generalized Technology Usage questionnaire (GTU). It explores impacts on teacher's perceptions including i) limits, ii) strategies, and iii) support. It is proposed that in order to effectively integrate technology, a teacher must negotiate and move through variety of barriers and limits and continuously evaluate and adjust their teaching strategies and support needs. This is done within the dynamic environment of the teacher-student feedback loop. As the teacher is using technology, students provide an ongoing and dynamic feedback loop for the teacher. It is important to remember that integration of technology is a process and that the teacher-student feedback loop can be used continuously to show how the

dynamic environment influences the teacher's belief, perceptions and technology use for teaching students.

Chapter 5: Methodology

Qualitative methods of inquiry obey a different set of criteria than quantitative methods of inquiry and as such, this narrative process produced large volumes of important and useful data by which to understand perceptions of technology and its integration in teaching.

This thesis design is broken down into the following sections: (a) Method Development and Focus: development process, research site, selection of participants, description of the participants; (b) Data Collection and Analysis: data collection, data analysis, data analysis tools; (c) Protocols: participant's security, confidentiality, researcher role and conflict of interest limits, ethical concerns.

Method Development and Focus

Development process.

Due to the complexity of individual perceptions, this thesis investigated the factors that influence technology integration using an explanatory sequential mixed method design of both quantitative and qualitative approaches. Data collection consisted of a pre screening questionnaire for the three-staged interview process. The narrative design was chosen for the primary research foundation as, I believed, a quantitative method alone would not fully address the richness of personal experience gleaned from the data to answer the research question.

Initially, research was conducted to frame my research questions using similar terminology and structure but a different pedagogical focus. The Technology Acceptance Model (TAM) was used to develop quantitative measures, specifically, the *General Technology Usage* (GTU)

questionnaire. The rationale for using quantitative measures within this research design was to gather initial information about how technology is used or perceived, and to select participants for the interview process who used technology a minimum of five-hours per week. As well, it oriented questionnaire participants to the research and provided the beginning framework for a more complex inquiry. Collaboration with my thesis supervisor, we developed accurate quantitative scales for the questionnaire to make sure they were correctly aligned, as he has a quantitative background. The TAM was used to formulate specific questionnaire questions (i.e. types of technology used: PowerPoint, spreadsheet, Internet, audio). The results of the *GTU* identified potential interviewees and a baseline of data.

The TAM's measures of Perceived Use (PU) and Perceived Ease of Use (PEU) formed the basis of the open-end interview questions which allowed each participant to speak freely about his or her experience of using technology in his or her teaching.

To delve into the lived experiences of teachers, the qualitative interview steps described by Creswell (2007; 2013) were followed throughout the data collection process to ensure complete cooperation from participants and trustworthy responses: (a) Design and use an interview protocol form; (b) Pilot test and refine the interview questions; (c) Identify interviewees/participants based on purposeful sampling procedures; (d) Determine the place for conducting the interview; (e) Obtain consent from each participant (f) Determine the best type of interview; and (g) Record the interview for transcribing.

These procedures were undertaken and the forms and interview question protocols can be found in the appendices B, C and D.

Throughout the thesis, participants were asked to share their experience with technology, teaching experience, their personal background, which courses they were currently teaching, how

they integrate technology daily, and what their vision of a future classroom might look like. The wealth of data that was collected fits well with the Narrative design and was seen as the best option for the trustworthiness of this thesis.

A meaningful approach to data collection and the focus of maintaining an open-ended interview process helped to record the participants' experiences. Squire's (2008) definition of narrative inquiry argued that this method allows for the narrator to retell and share how individuals make sense of themselves and the world. Bruner (1990) argued that the life experiences that infuse the data establish the primary topic and should be thought of as the true 'narrative'. For some narrative researchers (Chamberlayne, Rustin & Wengraf, 2002; Hollway & Jefferson, 2000; Labov, 1997), personal narratives, like the ones in this thesis, are founded on what they tell us about the individual's thinking or beliefs as opposed to whether or not the narratives themselves are about events or experiences. Since this research poses questions which are centered on the *perceptions* of the participants towards technology, their responses are the primary focus and establish the truest of narratives for the study inquiry.

Research site.

This research study took place in a large city in Eastern Ontario. The school board has just over 9,000 employees. This school board is committed to creating an atmosphere of well-being and promoting community engagement. It also understands that teachers can be leaders and experts within their classrooms, schools, and organization. It is committed to promoting and supporting employee growth and encourage lifelong learning. In October 2015, the school board published a document outlining a wealth of information and strategies to prepare all students for our technology-dependent society focusing on skills of digital access, commerce,

communication, literacy, etiquette, law, rights and responsibilities, health and wellness, and security. The school boards focus is to prepare students and to build their confidence before they reach the secondary school.

After reviewing the board's website, I was unable to find a similar document for grades 9-12 classrooms or a paralleling document to ensure secondary teachers are fully prepared for the level of expertise that is entering their classroom. The absence of a secondary level equivalent document seems to provide evidence of the importance of this thesis.

By having participants who work in the same school board, the teachers may have been exposed to similar external environmental norms in regards to professional development opportunities from the school board as described in the conceptual framework. Alternatively, each school is responsible for providing its own professional development opportunities throughout the school year and therefore some training at this level may impact the participants' experience.

Selection of participants.

This thesis focused on the integration of technology within the classrooms of 5 science teachers because, as a qualified intermediate/senior science teacher with Physics and Biology teachables, I wanted to research a topic that was practical for my professional growth and the potential success of my students. For this reason, secondary school science teachers were the primary participants for this study. As will be described in the Discussion chapter, although the participants all taught science (albeit at different curriculum levels) at the time of the interviews, their experiences and stories might be generalizable as common across all pedagogies.

A two-stage recruitment process was used to ensure data of a quality were collected throughout (Creswell, 2012). This process included a preliminary General Technology Usage (GTU) questionnaire, which identified potential interviewees.

I made attempts with administration of each school to inquiry into an accurate list of the science teachers within their school but I was unsuccessful. However, I went on the school board website and, school by school, looked at who was listed as teaching science courses. Using this method as well as by making use of my experience as a supply teacher and my networking connections with principals and heads of science departments within the local school board, in May 2014, over 230 GTU questionnaire were mailed out to a convenience sample; this included all intermediate/senior (grades 7-12) qualified science teachers who were listed as teaching at least one science course within this large board in Eastern Ontario. The questionnaire focused on the teacher's current usage of technology in and out of the classroom as it pertains to teaching and learning. It also looked at the degree of usage in their personal lives. Other demographical data such as age, gender, grades and subjects taught in the past and present, as well as years of experience and any professional development courses taken within or outside of the board were also obtained. A copy of the GTU questionnaire as provided in Appendix A.

Of the 230 questionnaires sent out, 20 responses were received (roughly 8.7% return rate). Of the 20 questionnaires received, 40% were self-identified as female teachers. The remaining 60% self-identified as male. While there were varied levels of teaching experience, 55% of questionnaire respondents reported to have 7 years or more experience using technology in their classrooms, but only 35% reported using technology in their teaching practices for more than 10 hours per week. In other words, I had 10 teachers who qualified for the interview process, by using technology 5 hours or more per week in their teaching.

As the questionnaire looked at the teacher's level of usage of technology in and out of the classroom, teachers were also asked to provide a link to their classroom and/or personal websites if they exist. The request for these links was for the purpose of gaining further insight into their lived experience and level of familiarity with technology. To protect the confidentiality of these teachers and their students, these details are not included in this thesis. At the conclusion of the questionnaire, participants were asked for their willingness to take part in a three-staged interview process. A secondary consent form pertaining to the interview process was supplied in the original recruiting package.

In order to elaborate on the quantitative data obtained from the questionnaire, a major requirement for participating in the three-staged interview process was a mandatory technology usage of 5 hours or more per week. My reasoning behind the 5 hours per week usage requirement was to gain a clear image of the experience a participant goes through when using technology consistently and continuously in their classroom. For example, a full-time secondary teacher teaching in a semestered school will have 3, 75-minute, periods with their students each day. For participants using technology 5-hours or more translates to 300 minutes of technology usage each week. The 5-hours per week requirement is equivalent to 25% of their teachable time. If a teacher uses technology for the full 75 minutes, their weekly usage would extend to only 4 periods. In my experience, with differentiated learning and student learning accommodation, many teachers do not use technology for the full period but instead add it to the mix of teaching tools they use daily. There are 1,125 teaching minutes each week for a full time teacher. For this reason, teachers using technology less than 5 hours per week were not chosen for this study. However, a subsequent exploration of those teachers not using or who are at the beginning stages of their technology usage and integration, may prove to be a valuable research opportunity.

Participants who showed an interest and met the mandatory technology usage requirements, were contacted to set up a convenient time for the first interview. Of those who agreed and who met the weekly usage criteria, 8 participants were contacted but only 5 participants gave consent to be interviewed.

By examining the level of usage, their perceived difficulty or comfort with technology, and comparing their in-classroom usage with their personal usage, an initial descriptive statistical analysis as described by Trochim (2006) provided a summary of the level of technology usage of intermediate/senior science teachers who took part in the questionnaire portion of this study. Next, an inferential statistical analysis (Trochim, 2006) was applied to the GTU questionnaire data in order to decipher the level of technology acceptance among teachers and identify a purposeful sample of five ideal questionnaire participants for three follow up in-depth interviews.

Description of the participants.

Five interview participants met criteria which deemed them to be technology users; they were selected for follow-up interviews because of their knowledge, experience, and professional capacity based on results of the descriptive and inferential analysis. While it might be noted that these five teachers represent a purposeful sample, I cannot claim that they are representative of the teaching profession as a whole.

Pseudonyms have been created for the five high school teachers (Brendan, Carl, Lindsay, Oliver, and Randall) in order to anonymously share their compelling stories. A more in-depth description of each is provided in the participants' narratives starting on page 63, where the reader can see a summary of the experiences of each participant as they have adopted, adapted,

and developed their competencies with technology within the classroom. Each narrative effectively illustrates the movement and growth of each participant as they integrate technology into their classroom.

Data Collection and Analysis

Data collection framework.

For the purposes of this thesis, the Technology Acceptance Model has been adopted as the guiding framework and foundation for the development of a questionnaire and informs the interview protocol. It has been used in previous research (Jan and Contreras, 2011; Shin, 2008; Willis, 2008) to explore teacher's perceived acceptance of technology, and to fulfill the objectives of the study. From these studies, it appears that the TAM has strong merit as a quantitative method for answering hypothesis and factorial data. For this reason, I specifically used this framework to guide the development of my General Technology Usage questionnaire. More detail on this process is below.

For the main body of my research objectives, the TAM model of Davis (1989) and Bayrak (2013), were used to illustrate and explore the interconnectedness between the complex dimensions of the teacher perception and the usage of technology in the classroom (perceived usefulness, and perceived ease of use), the attitude of the teacher, the teacher's intentions for using technology, and finally the actual usage of technology by the teacher were the focus of the multiple layers of data collection.

There are many factors that inhibit the acceptance and ultimately the success of technology integration. The TAM was chosen specifically because, despite how commonplace technology is

in our society today, for some, it can be an overwhelming and stressful experience, especially when asked to integrate it into their already busy professional lives (Aldunate & Nussbaum, 2013; Belland, 2009; Flores, 2002).

For these reasons, by uncovering the perceptions of teachers through the framework of the TAM, we can begin to understand teachers' beliefs about the perceived consequences of using technology in the classroom and how these perceptions can influence their decision to use technology in their teaching and learning practices. By focusing on teacher beliefs, professional development needs can be explored to establish positive perceptions of technology usefulness and ease of use. These are the goals of this study.

Data collection.

As described above, the initial stage of data collection, the GTU questionnaire, took place through a mass mailing approach. After questionnaires and consent forms were received, the second stage of data collection began. Participants provided their telephone number at the end of the questionnaire if they consented to being interviewed. The 3-staged interview process took place by telephone at a time chosen out of convenience for the participants. Data collection was guided by phenomenological interviewing strategy proposed by Seidman (1998). This kind of interviewing process serves the very specific purpose of exploring and gathering experiential narrative material, stories, anecdotes, and my observations and experiences within the interview, to serve as a resource for developing a rich and deep understanding of my research participants. Further detail of the value of this strategy can be found in the next section.

Data was gathered using a three-tiered, in-depth interview process composed of phenomenological inquiry as outlined below:

Interview 1: Explored the teacher's past experiences with using technology.

Interview 2: Explored present experiences.

Interview 3: United the two narratives to describe the teacher's experience with using technology.

The in-depth, semi-structured interviews were conducted with five intermediate/senior qualified science teachers chosen from the initial questionnaire data analysis. Interview questions were open-ended to allow the participants to speak freely and openly about their experience with technology and describe their perceptions of its usefulness in the classroom as well as to limit any influence or bias from the researcher.

Interview questions were tailored around the technology acceptance model (TAM) and allowed for the story of the participants' lived experiences to echo through in their responses. All participants were available for the three-tiered interview process and were asked the same open-ended interview questions. This study's interview protocol can be found in Appendix B.

Interviews were conducted over the phone after school hours so to not disrupt or impose on valuable teaching and preparation time. Interviews were carried out over a three- to four-week period from start to finish starting in late April 2014 and were dependent on the availability of the participant. Interviewing teachers mid-semester helped to assemble an illustration of the factors that influence a teacher's use of technology and the level of knowledge and skill up to that point. Reflective field notes were written after each interview comprising of my thoughts and any additional themes that could be brought up in the follow-up interview(s). Each interview was audio recorded and all 15 interviews (3 per participant) were transcribed within a one-month period following collection.

As previously noted, this research is centered on the following leading research question: How does a purposeful sample of experienced local public school secondary science teachers perceive the usefulness and effective integration of technology in their classroom?

As well, there were three secondary research questions:

1. What specific limitations or constraints do these teachers perceive as affecting their attempts to incorporate technology into their classroom?
2. What specific teaching strategies do these teachers perceive as being useful in the incorporation of technology into their teaching?
3. What specific supports do teachers perceive as being necessary for the incorporation of technology into their teaching?

Even though there were only five participants in this thesis, there was a large amount of raw data gleaned from these questions and the discussions that evolved. A description of the analytic approach is described below.

Data analysis.

Quantitative and qualitative data was collected sequentially in two phases as described above. The sequential explanatory mixed method approach to this study is justified through this design, although, as noted by Ivankova, Creswell and Stick (2006), is not without limits since the interview participants (qualitative data) are members of the same professional communities as the questionnaire participants (quantitative data). Participants work within the same school board, attend the same board wide science professional development days, and may even teach within the same school environment and department. This is a critical distinction to this study

because, as Fisher (1987) describes, people make decisions based on good reasons determined by history, biography, culture, and character. In addition, as learned from the technology acceptance model, social environments can be influential to our behaviour and how we tell our story. Therefore, it is my belief that the sequential data collection method and inclusion of the quantitative data analysis is crucial for refining the essences of the participants lived experiences with technology.

Narrative theory.

To assist in developing an understanding teachers' perceptions of technology, the narrative theory approach was taken to give the participants allowance to be heard.

Working within the paradigm of Phenomenology, it was decided that although a Case Study approach could focus on people, organizations or institutions, or events and occurrences, the data did not fit into an anomalous case or paradigmatic case type as described by Creswell (2013). It could be argued that the data fits into the critical case type as participants were chosen specifically base on their 5 hours per week usage of technology but in the end, narrative theory was chosen as the qualitative data collection method to ensure the collection of participants experiences from the first-person. This section will show the justification for this use of narrative theory as the second phase of this explanatory mixed methods thesis.

Narrative theory was first developed by Walter Fisher (1987) and posits that: individuals are essentially storytellers. Supporting this notion, Warnick (1987) agrees that narrative rationality is determined by the coherence and fidelity of our stories; the world is a set of stories from which we choose, and constantly re-create, our lives. According to Fisher, the narrative paradigm is all-

encompassing and all communication can be looked at through a narrative lens. Narrative theory is an inductive mode of inquiry which deems that individuals are able to distinguish what makes a story legitimate by using narrative rationality. According to Fisher narrative rationality is comprised of two factors: coherence and fidelity. Coherence can be best defined as if a story makes sense structurally. Is the story consistent, with sufficient detail, reliable characters, and free of any major surprises? The ability to judge coherence is learned, and improves with experience. Narrative fidelity is concerned with whether or not the story is true. Fisher establishes five criteria that impact a story's narrative fidelity: (a) questions of fact that examine the values embedded in the story, either explicitly or implicitly; (b) questions of relevance that consider the connection between the story that is told and the values being espoused; (c) questions of consequences that consider the possible outcomes that would accrue to people adhering to the espoused values; (d) questions of consistency between the values of the narrative and the held values of the audience; (e) questions of transcendence that consider the extent to which the story's values represent the highest values possible in human experience (Warnick, 1987).

Fisher illustrates the importance of understanding the richness of another person's experience and that it is an inductive process. For this thesis, the participants' narratives were essential to my understanding of teacher's perceptions of technology integration and Narrative theory was a choice of theoretical framework. Narrative strategies focus on paying attention to the various themes within people's stories and coding and categorizing based on patterns, themes, and regularities as well as contrasts, paradoxes, and irregularities. These themes form the foundation of meaning making.

Narrative theory as a working research method.

In this section I will illustrate my usage of narrative theory as a working research method for this thesis and how it guided the structures of the data analysis.

It is important to note that I found the results of the interview process, reflective notes, and questionnaire responses to possess many details. This produced a conundrum. I wanted, on one hand to stay as close to the teachers' narratives as possible and to honour their unique experience and stories. On the other hand, there were so many useful themes within the text that I also found myself wanting to dissect and organize the themes. In the end, I elected to add to my learning curve and develop my research acumen by doing both. In doing so, there is much that can be learned about teachers' perceptions and technology integration, and will be of practical value as technology continues to be infused into school.

A concern of mine is that the participants' stories may be seen as vulnerable to interpretation. To address these concern, the initial drafts of this thesis, were filled with the direct quotations of the participants. Upon careful revision, although the quotations provided a true first-person account, they did not add direct value to the reader. While not included, no attempt to simplify the narrative research was made because doing so would not do justice to the richness of approaches, theoretical understandings and unexpected findings narrative research has to offer (Squire, 2009). Hammersley's 1992 paper entitled "*What's wrong with ethnography?*" argues that the truth or validity of an account is valid if it is representative of the features of the phenomenon it is intended to describe, explain, or theorize. He also argues that an account is relevant or useful to a community of scholars if the topic is important and the findings make a significant contribution to the knowledge of the field. It is specifically noteworthy that

Martinovic, (2011) believes that by intentionally highlighting the moments of frustration and disappointment within the teachers' narrative of their technology usage, they are providing a rich account of the entire experience, including the disenchantment with the technology, thus forming a level of trust with their peers.

In order to assess the validity of research conducted using the narrative methods, Mishler (1990) identified the following key questions: Is the method appropriate for the study purpose? Is the method well-described? Have central aspects of the method been implemented? Is the study free of obvious error and bias? Have rival explanations been considered? In response to Mishler's questions, Wells (2011) proposes that additional information is required in order to address the above stated questions. She believes that the central conceptual and methodological issues of a study need to be clearly defined so that they can be evaluated. She also proposes that additional information needs to be provided as it relates to the conditions of that narratives' production, analysis, and interpretation.

During my initial exploration into narrative research, Emerson and Frosh (2004) define this type of research as a relatively coherent personal story, with a beginning, middle, and an end, that is co-constructed by an interviewee and interviewer. In its application, the interview protocol of this thesis was set as a three-staged interview process exploring participants past and present perceptions and their perceived future use of technology usage in their classrooms.

Understanding their perceptions of technology in the moment and asking them to think about how their technology usage would look in the future, provided great insight into their motivation to continue the process of integrating technology into their teaching and learning environments.

As I continued, I found that different narrative approaches have different emphasis; some may be layered or organized to tell a story; others focus on interconnection which portrays a

complexity of the phenomenon. In particular, Polkinghorne's chronological organization or diachronic organization narrative analysis (1995) utilizes "narrative reasoning" by shaping data in a narrative form and doing an in-depth analysis of each narrative on its own. Bruner's functional approach (1991), on the other hand, focuses on what roles narratives serve for different individuals to construct and make sense of reality as well as the ways in which meanings are created and shared.

With this in mind, the shared experiences of the participants were in-depth and rich with meaning such that this thesis utilizes both Polkinghorne's and Bruner's narrative methods to analyze of the interviews. The qualitative data presented in this thesis findings, is broken down into two chapters: Chapter 6: Qualitative Narrative (using Polkinghorne's Narrative Analysis, 1995) and Chapter 7: Qualitative Themes (using Bruner's Functional method, 1990). Although research participants share the commonality of using technology, they differ in their applications, classroom materials, personalities, and school or classroom setting. Polkinghorne's Narrative Analysis (1995) utilizes researchers to "collect descriptions of events and happenings and synthesize or *configure them by means of a plot into a story or stories*" (pg. 12). The qualitative *narrative* section of this thesis gives voice to each participant's unique story.

From the interview protocol, the themes of the thesis were developed. The qualitative *themes* section seeks to answer the secondary questions of this study by using Bruner's Functional methodology (1991) to analyze the themes, contradictions, and paradoxes within all narratives to better understand the commonalities of experience. For Bruner (1991), individuals do not make sense of the world around them through single events. Instead each individual event is added to and framed within a large structure of many events. Common and divergent

experiences (including patterns, themes, and regularities as well as contrasts, paradoxes, and irregularities) are analyzed to give a depth of understanding.

This thesis also adopted some of the research strategies of narrative design as proposed by Creswell (2013) and utilized the narrative and inductive coding paradigms described by Miles and Huberman (1994).

Data analysis tools.

Quantitative data obtained from the General Technology Usage questionnaire was examined through a descriptive analysis method. I used a simple Excel table and graphing tool because the sample size was too small to do formal statistical analysis.

The intent of this research study was to analyze interview transcripts, reflective notes, and questionnaire responses using the research software known as Dedoose². This software was chosen over others to assist in identifying and organizing data into themes that describe the essence of the teachers' experiences and their perceptions of the usefulness and the ease of use of technology on teaching and learning because the more popular and well-known software of Nvivo³ was not available for Macbook computers when software was purchased. The software was thought to be helpful in revealing the interconnectedness and deep multi-layered influences of classroom technology acceptance and integration through the process of keyword analysis.

² More information on the Dedoose software can be found at <https://app.dedoose.com>

³ More information on the Nvivo software can be found at http://www.qsrinternational.com/products_nvivo.aspx

In the end, the technology proved to have too steep a learning curve for myself and the process of inputting the raw data was too time-consuming. Thus, ironically, I didn't use research software. Rather, I practiced the traditional method of watching for emergent themes and coding and clustering them into coherent categories. This raw data was organized to hone in on the research question. This involved examining the text database line by line, clarifying the participant's words and meaning, separating irrelevant or redundant material and looking for patterns, themes, and regularities as well as contrasts, paradoxes, and irregularities. Study findings, using this method, were rich and meaningful.

It is important to explain the structure of the narrative design for this paper. The interview protocol for this study was designed to provide the participants with ample opportunity to describe and share their past and present experiences with technology and how their perceptions of the usage of technology influence how they integrate it into their classrooms. While reviewing the transcripts of the three interviews, I noticed that the questions being answered could be categorized into headings for the analysis according to the method of Miles and Huberman (1994). The headings are as follows:

School Life: In this section, I introduce the participant and their school. I have chosen the details carefully to keep the participant and their school confidential but, at the same time, to illustrate the level of support or school community focus in regards to technology, academics, and extra-curricular activities.

Acquiring the Necessary Knowledge and Skills: In this section, I have included the interview responses that showcase the participants' journey and experience with technology.

Time for Integration: In this section, I have included the participant's feelings regarding the amount of time they have invested into integrating technology, refining their skills, and learning

new technologies on their own time.

Advice to Teachers Wanting to Integrate: This section was included because I recognized the wealth of experiences these participants were sharing with me. To be considered for the interview process of this study, the participants had to be using technology in their teaching a minimum of five hours per week. This constraint allowed for an abundance of knowledge, experience, and purpose to be drawn from the interviews.

Ahead of the Curve: Taking into account the usage requirements needed to participate in the interview process of this study, this section elaborates on how these participants use technology and their reflections about why they may be different from those teachers who are not yet using technology to the same degree. This section is not meant to suppose that these teachers are experts or have mastered the technologies that they are currently using, but rather to illustrate to the reader the perceptions of the participants, when they feel successful, and what strategies they use when teaching with technology.

Hopes, Fears, and the Future: This section examines the participants' reflections of their classroom and the optimism and challenges they perceive for the future when integrating technology.

Each participant has their own narrative. There are five narratives in total following this structure.

Protocols

Participant security.

Each participant was sent the interview protocol and questions prior to our scheduled

interview time, to prepare, explore, and reflect on their experiences. They were not forced to participate and were told in their *Letter of Information* (Appendix C) as well as their *Consent Form* (Appendix D), that they could withdraw from the study at any time. I made it known to my participants during the questionnaire stage as well as in the beginning stage of the interview process that I was a science teacher within the same school board in which they taught.

Confidentiality.

For the purposes of this thesis and the local nature of the research, I provided each participant with a pseudonym to protect their identity. The five participants in this thesis are all high school science teachers. They come from the same school board but teach at different schools within the board. I felt this distinction to be an important characteristic of the data collection process. This choice has been geographically convenient as well as expedient as I did not have to apply to multiple ethics boards to begin my research study. For any subsequent study, since the science teachers in this thesis did not speak about specifically of technology experiences relating to their science pedagogy, I would expand this research to include additional pedagogies within the same school board to maintain the similar professional development exposure.

Researcher role and possible bias.

In Polkinghorne (2007) study, he specified that when establishing the validity of a study it is important to have a discussion or consideration of the extent to which the interviewees feel safe in the interview and explore reflectively their experiences. With respect to Polkinghorne, the narrative method, and for the trustworthiness for this thesis, it is important to establish my

relationships with the participants and/or their schools. As a supply teacher within the same board as my teacher participants (and being a qualified Physics and Biology teacher), I have participated in two science professional development days. I also sat on the Science Council which organized these events. Although none of the participants were involved on the council, they may have had previous knowledge of me or my name from my involvement on the council or during professional development events.

In the interest of full disclosure, I will briefly outline my knowledge of participants, their schools and my use of technology equipment. I taught summer school for two years at the same school as Carl. At that time, he was teaching grade 11 Reach Ahead in the Physics classroom and I taught grade 12 Reach Ahead next door. Since our subjects were related and many of the supplies that I required for labs and demonstrations were in his classroom, we spoke often. We brainstormed ideas together and assisted each other with anything we could, including the sharing of resources.

Additionally, I taught summer school at Randall's school in the past, though I had not met Randall prior to this study. I have made use of technological equipment within my teaching position there.

Of all of the participants, Oliver is the only one whom I knew on a more personal level. I was a supply teacher with a Physics teachable and I was often called to cover Oliver's classes when he was away. The longest I taught in his classroom was for 10 days. I was amazed at the usefulness of his Smartboard. His classroom was set up so that when one walked in the door, lab benches were immediately available. His 'teacher' computer was placed on a smaller lab bench in between the lab area and the classroom area facing the students' desks. Walking further into his classroom, the students were seated at long tables placed in two wide columns with aisles in

the middle and along the sides. His teacher desk, more of a longer lab bench, was in line with the far column of student desks. His Smartboard was centered to this middle aisle. He is fortunate to have his projector screen mounted to the ceiling so that he does not have to calibrate and recalibrate his Smartboard every time he turns it on. Although I have supplied taught for Oliver many times, I have also supply taught for other teachers in his department so have been in the school when Oliver has been teaching. Thus, I have spoken with him face-to-face at times as well.

Despite having no previous experience or relationship with Brendan and Lindsay, or their schools, I felt both participants were comfortable during the interview process.

I am privy only to the information shared within the interview process, the information I have researched within school environments, and values from the school board's website. I have not found any information which contradicts participant reports, school board policies or website information. I felt that the data I collected from them during the interview process is trustworthy.

Ethical concerns.

This thesis focuses on the perceptions of teachers. Data collection took place outside of school hours. There was no risk and no vulnerable populations were affected by this thesis. Due to time constraints of this thesis, participants have not provided with a copy of the findings prior to completion as a means of member checking. Both Brendan and Randall showed an interest in the final results of this thesis. Upon completion of the program, each participant will receive a copy of the final research project. If there is an interest, I will be available to discuss the conclusions of this thesis with participants.

Chapter 6: Findings

Quantitative Data

Demographics.

The data gathered through the questionnaire helped shed light on how these teachers were using technology in their teaching practices and what challenges they faced in their integration. Of the 20 questionnaires received, 40% were self-identified as female teachers. While there were varied levels of teaching experience, interestingly, 55% of questionnaire respondents reported having seven years or more experience using technology in their classrooms. However, only 35% reported using technology in their teaching practices for more than 10 hours per week.

For some, teaching was sometimes a second or even third career choice. Reportedly, 85% of respondents were over the age of 35 and 50% were over the age of 45. No questionnaires were received from respondents who were under the age of 25 years. Interestingly, only 15% of respondents were between the age of 25 and 34 years. A future study, or extension of this thesis, could focus on uncovering the relationship between age and technology experience.

Whether a teacher obtained a teaching position right away, or worked as an occasional teacher for a time, teaching experiences help develop their confidence and skills. When reviewing the data, it was interesting to see the diversity of the respondents' teaching experiences. Forty-five percent of respondents indicated having 5 – 14 years of teaching experience. One could see this as a possible limitation of the data set, but it is important to remember that teaching is sometimes a second career and some may also start their professional

teaching career later in life.

Technology usage.

The use of technology in education can enhance student learning throughout the education system. Remarkably, all of the questionnaire respondents agreed that this statement is also true within the discipline of science.

There is a misconception that older teachers may be reluctant to change and less likely to integrate technology into their classroom. When the questionnaire data was viewed through the lens of the respondent's age, I saw that this is not true. Older teachers have more experience with technology and are using technology in their classroom five hours per week or more.

A deeper analysis of the data collected showed that the number of years of technology experience increased as the participants' age range increased. When we look at weekly technology usage, I noticed that older teachers here using technology more hours per week than younger or newer teachers. There is a misconception that age determines your technology usage and comfort using technology. In this study, older teachers seemed to be just as capable and eager to use technology as the younger teachers. This may be due to pedagogical proficiency. Further possible reasons for this result will be presented in my discussion chapter.

Based on my personal experience, there may be many factors that influence an individual's perceptions of the usefulness and ease of use of technology. For myself, as a novice teacher, a limited usage of technology may be reflective of the strain or limit of time to learn how to appropriately use the technology due to the large factor of having limited exposure to their course material. Teachers who have more experience teaching a particular course may feel fewer time restrictions when it comes to navigating and learning how to incorporate new technology

into their classroom as they have more confidence in their understanding of the curriculum to allow them to explore other teaching methods.

Although within this sample group, 55% of respondents self-identified as having more than seven years of experience using technology in their teaching, 2 respondents self-identified with having less than one year of technology experience in their classroom. At the rate at which our society is becoming dependent on technology, it is noteworthy that some teachers still have limited experience with technology in the classroom.

My respondents agreed that the use of instructional technology enhanced their teaching. When respondents were asked what types of tools they used in their teaching, there was a varied response across the board. The instructional tools most used by respondents per week were: presentations, followed by Internet content, videos and animations, and discussion boards and Wikis.

The data is very compelling with regards to the science curriculum and which instructional tools have been chosen to be integrated into the classroom. Presentation tools such as PowerPoint or Google Slides make the delivery of the curriculum neat and clear, whereas Internet content, videos, and animation help to illustrate the complex laws, theories, diagrams, and content of the different science disciplines. More details on how individual teachers used these tools, and the benefits and limitations of the most popular, are explained in the Qualitative Narratives of the five teacher participants.

When it comes to the training of these teachers, it was evident, that there was a lack of availability. More than half of the respondents, disagree that they have adequate training opportunities to develop their technical skills at their institution. Despite the lack of adequate training, 10 respondents agreed that the administration within their school was supportive of their

use of technology in education.

It is interesting to note that when asked what factors hindered the respondents from trying new technologies, the highest reported factors were time, followed by lack of training, lack of support, integration ideas, and availability of technology. These results have been illustrated in Figure 4 below.

These hindrances could be the leading factors that influence an individual's acceptance of technology, how they choose what to use, and when they decide to integrate technology into their classroom.

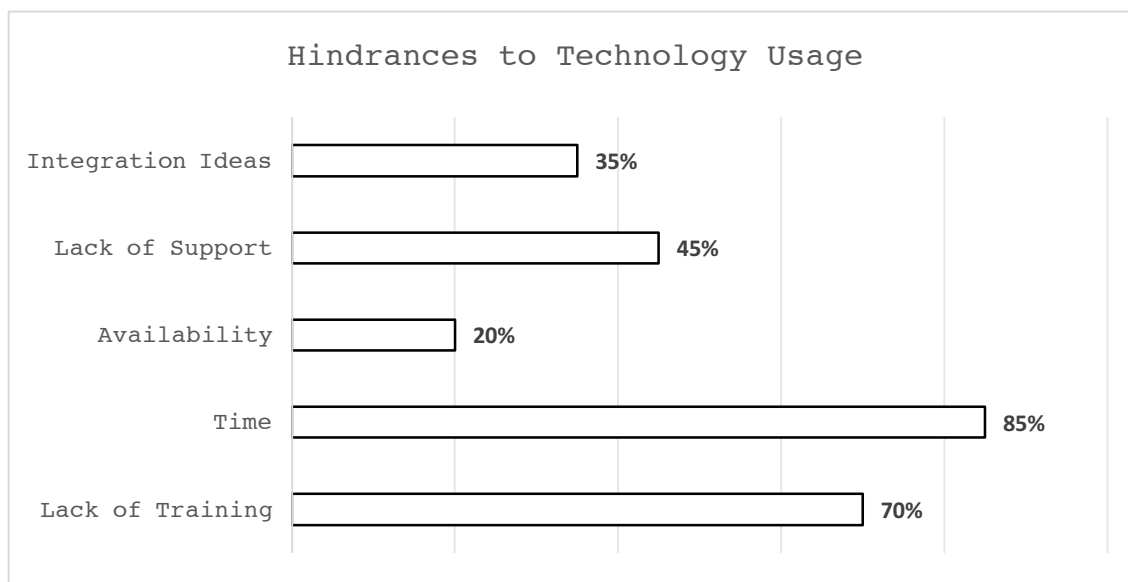


Figure 4: Hindrances to Technology Usage – Participant responses to GTU questionnaire question “*What hinders you from trying new technologies?*” Participant self-identified experiencing multiple hindrances. The five listed, are the top hindrances reported.

Qualitative Narrative

Life in the Classroom: A Narrative Telling of Five Experienced Teachers' Perceived Usefulness and Effective Integration of Technology in Their Classroom

Brendan's story.

School Life

Brendan Dempsy was a teacher and Science Department Head and was between the age of 25 and 34. At the time of this study, he was teaching grade 9 and 10 Locally Developed Science and grade 12 Workplace Science at a vocational high school in a suburban community in a major city in Eastern Ontario. His school offered a semestered program with career and technological education to students in grades 9 to 12 who are interested in the trades.

Acquiring the Necessary Knowledge and Skills

When I first spoke with Brendan, I asked him if he could describe his experiences in acquiring his knowledge and skills when it comes to technology usage. With between 5-14 years of teaching experience behind him, Brendan had been using technology in his teaching practices for over five years. Before he went into details, he shared that his classroom may not be the norm and may be different from that of his colleagues. Brendan had spent the last few years setting up his "paperless" classroom where everything was done through the Google platform, utilizing the collaborative abilities of Google Docs. He had been "basically self-taught through trial and error" and was literally "Googling" (using Google to look up answers) when he could not figure

something out. His students were a great asset to him and tried to work out issues they had together with him. His self-directed approach has allowed him to stay ahead of the game in terms of where the school board is in regards to his usage of technology.

Working online has allowed him to do a lot more inquiry-based science because he can give his students a bigger, broader question and they could take their results and then do some research and try to figure out some connection to some real-world applications. Working at a vocational high school, his classroom may not be like most:

I deal with a fairly marginalized group of kids who have not had a lot of academic success so that fact that they can share their knowledge with each other about something we're looking at – that is a powerful tool in itself.

This process and dedication does not come lightly, and with over 10 hours per week of technology usage, Brendan could see the benefits to his students:

One of the big things that has really helped me in my teaching and with the strategies is that we have a large number of kids who have assistive technologies and other things on their IEPs that require verbatim scribing. Many of them have reading and writing difficulties.

He described that “they can talk to the iPad and Siri will write in their Google Doc.” Since his classroom was online, students had access to the technology wherever they were and could overcome these difficulties more easily than if he had not provided a paperless classroom. They could use their technology to assist them.

Time for Integration

It is important to set realistic timelines for the infusion of technology. Ones goals must be individual and realistic. For Brendan, he knew his abilities. He was hoping that within the next couple of years, as he and his students become more comfortable with technology and how to use it, he would be able to use these platforms as a means to share the knowledge his students have already acquired:

...the fact that they can share their knowledge with each other about something we're looking at – that is a very powerful tool in itself.

Unlike his junior students, many seniors in his classes were more involved in taking ownership of what they were learning in class:

We're doing ionic bonding and they wanted to know what was going on in the D-energy levels and I said to them honestly 'It's been 15 years since I've had to deal with D-energy levels. I don't have a clue what's going on in there' and they feel comfortable going to the Google. We call it the 'Google-machine' and away they go. They've really embraced that and part of it is the scary bit of having to give up part of that control to the kids and just say 'hey, you're going to decide to use your time slightly different than I envisioned it but that's okay. You're still getting some kind of authentic learning out of this in the great scheme of things'.

Being able to give his students the opportunity to adventure out and ask questions demonstrated Brendan's belief in the usefulness of technology in his classroom.

Advice to Teachers Wanting to Integrate

Brendan was a leader in his school for his usage of technology, and he had some colleagues who were ready to start the integration process within their own classrooms, but there was a problem getting resources and the actual hardware for those teachers to use in their classroom. When I asked Brendan what advice he would give his colleagues who have a desire to begin the process of including technology in their instruction, I was not surprised by his response.

The best advice he could give was to "jump into the deep end and just go". This can seem extreme to some, but if you truly have a desire to use technology to benefit your students, it is best not to dabble. He shared an example of colleagues within his department: for those who tend to dabble a little bit here and there were not using the technology to the best of its ability. For him, the use of technology was to encourage inquiry-based work where his students were sharing work back and forth and where knowledge was fluid. He feared that if one was just dabbling and not fully integrating technology then it would not allow as authentic inquiry. He urges that being comfortable enough to just jump in and do it was easier, especially if you had an administration at your school that will support you.

Ahead of the Curve

Brendan believed that one way he was different from the teachers who were not integrating

technology was that he used technology to focus on the whole inquiry base of science. His paperless classroom allowed him to create authentic discovery moments with his students because he was not worried about them taking notes. Everything Brendan did in his classroom was posted online to his paperless classroom. He was able to achieve this through using Google Drive. This platform gives students a way of sharing information with each other and it is accessible anywhere they have access to their Google accounts. The use of his Google Drive allowed his classes to really focus on the process of setting up a proper experiment. They were able to go through and reflect and ask themselves what they were going to learn and what they wanted to learn. In terms of the different scientific strands, using technology this way helped to opens things up so that he could focus more on the questioning and the thought process rather than the data management of what needed to be provided in a course.

When I asked Brendan to describe his role in the classroom while he was teaching with technology, he described his role as becoming more of a facilitator. He often told his students that he doesn't teach anymore. He told them that he was a "tour guide of science" and put the onus back on his students to take some ownership of their learning so that learning really depends on the effort they put in. As much as he hated to use the word "lecturing", he still had to do some formal teaching on different concepts because it helped to facilitate discussion. He was spending less time lecturing and trying to get the information across and more time with students sorting out what they were trying to get out of the course while making sure he was meeting his course curriculum requirements.

Being a technology front-runner at his school, Brendan had also taken on the role of tech-support within his classroom. He had developed the skills at troubleshooting, to the best of his abilities, and reverted back to traditional teaching methods when troubleshooting just did not

work. He shared a prime example:

On Monday, I was having my teaching appraisal done and Google kicked out at 2 o'clock in the afternoon. So there I am. We had to go back to good old paper and pencil. So we spent 10 minutes of my lesson trying to troubleshoot Google and it just turned out it just wasn't going to work.

On top of adopting a tech-support role, Brendan also adopted a student-support role rather than just being a provider of information. He was there for his students to help them along with their learning. While teaching at a vocational high school, he felt that a number of the students at the school had been passed along throughout the elementary system and high school could be an eye-opener for them. By allowing his students to have their own personal success and be able to take ownership and pride in their work, he gave them a huge victory. Giving his student these opportunities was a very positive affirmation that “I can do this stuff myself and be successful”. Giving his students that sense of ownership of “I can learn. I can figure this stuff out. The questions that I have are valid” will build a strong foundation for success when they get into the workforce.

His goal for his students was to help them to develop some self-confidence, skills, the ability to develop proper arguments and to sort things out when they don't work out. Brendan shared with me that:

In the 10 years that I've been here, it's really taken a real shift for me to really understand how connected these kids are 24/7. No longer do you go home and leave school at school. It's with you. All the social side of things and so it's

definitely been a different go of things. Hopefully, we'll help them with that to sort out what they need and what they can leave behind.

Brendan is a strong advocate for his students and wants to see them succeed outside of the four walls of his classroom. Helping his students develop the skills needed to make it in the workforce is just one of the many ways he is supporting his students through the use of technology.

Hopes, Fears, and the Future

When I asked Brendan what his hopes and fears were for incorporating technology into his classroom, he was taken aback. At the time of the interviews he didn't have any fears. However, he said that if I had asked him the same question this time last year, he would have had a different answer. His biggest fear last year was losing the technical support for what he was trying to do. He was fortunate however in understanding where the school board was interested in going in terms of their technology plan. He was able to establish himself as ahead of the game and when the school board adopted the Google platform, he was already set up and ready to go.

One continuing fear that he had was not having enough time to stay current with what's going on because technology is constantly changing. Trying to integrate technology can be very time-consuming. Brendan shared that he has a "screw-it moment" at 3:30 pm where he leaves the building and will deal with whatever is troubling him tomorrow. It is extremely difficult not to bring anything home. Brendan had to consciously un-plug and put his phone and other devices away. He admitted that he does check his emails up until right before bed – one of the

responsibilities of being a department head. He also admitted that it is important to have a work balance and home balance to put everything into perspective. “You have to truly align your thinking to “okay, I don’t need to be connected here all the time. There is way more to life than what goes on in this work world”. There were some clear advantages and disadvantages to being connected all the time. The key to success was to find the balance.

In Brendan’s perfect world, his best hopes for technology would be that all of his students have a device in his classroom that connects quickly, that the students would feel comfortable sharing information with each other and him, and building a sense of scientific literacy and community-based learning. He would like to see his students taking ownership for their learning. He continued to see himself as the facilitator to guide them along to validate what they’re doing. He also wanted to see technology in every classroom, so using technology in their learning is no longer a surprise but the norm.

Brendan would love to see a future classroom where there is very little paper used. Whether they are completely paperless like his classroom or slowly getting there, he would like to see less paper being used. His justification was that since students were going to come to class with their phones or other devices, the teacher would have one too. Everything could go to their inbox so instead of copying down the note or regurgitating it, the note would be there and they would have access to the information. It would then become a matter of how they were going to use the information: “What do I want to get out of this? What does the instructor of the course want me to get out of this?” At this stage, the teacher could develop into the role of facilitator in terms of showing students how to learn for themselves. Brendan found that he spent a lot more time in actual conversation with his students rather than talking at them. Using technology in this way increased the chances of meaningful conversation between students and teachers because they

were no longer spending all that time lecturing and frantically taking down notes. Now they could spend more time creating an environment where meaningful questions were being asked and where learning and sharing was encouraged.

Brendan could see the benefits of using technology in his classroom. He was taking steps to integrate technology and to help his colleagues be successful as well. He had tried to make technology available to the students by having machines in the classroom for everyone and encouraging them to use their own. He tried to keep the playing field as even as possible for his students. He found technology massively useful for the students at his school:

It's really allowed them to have a little bit of freedom in their learning. It's allowed for a lot more collaborative learning in the classroom. In terms of ease, I'd love to have some faster devices but again it's taught all of us a little bit of patience, it's taught us a little bit of problem solving, of okay we just got to kind of roll with it. For me, I can't see going back.

Technology allowed Brendan to conceptualize his teaching style in new ways and evolve his teaching strategies to benefit all of his students. Brendan wanted to prepare his students for their future by teaching them to take ownership of their learning.

Carl's story.

School Life

At the time of this study, Carl Smith, aged 25 – 34 years old, was teaching grade 9 applied

level Math, grade 12 Foundations for College Mathematics and grade 12 university preparation level Physics. His school offered a semestered program from grades 9 to 12. Curriculum was focused on the integration of technology by providing opportunities for students that include direct, hands-on experiences in courses such as Computer Technology and Entrepreneurial Studies, just to name a few. Carl's school also had a long list of achievements.

Acquiring the Necessary Knowledge and Skills

While speaking with Carl, he shared his experience acquiring technology knowledge and skills. With 5 – 14 years of teaching experience and over three years of experience using technology in his classroom, his experience in learning and building the skills needed to use simulations or the basics of a new program had been mostly a *learn as you go* process. He told me that it involved doing his own research and trying to work through the different programs. He shared that he was fortunate at his school that he had the support of his colleagues and there were those on staff who knew how to use the technology and could give him a short demonstration. He admitted that he does not follow the media when it comes to the newest gadgets or educational programs. He acquired some of his knowledge through attending Professional Development sessions provided by the school board or the secondary teachers' union and observing what other teachers within his discipline were doing. He was fortunate to be placed in a classroom that has technology as opposed to a classroom that does not. He went on, however, to explain that it was sometimes difficult to build on his skills and experience because there was a lack of "next-level" workshops that go beyond the introductory or novice skill set.

Time for Integration

During my first interview with Carl, I asked him how long he thought it would take him to infuse technology into his teaching in the way that he envisioned it. He regretfully admitted that he would never be able to infuse technology the way he envisioned it because he didn't believe that he would ever have an ideal classroom where he'd have a classroom set of computers and keep the space necessary to complete the scientific laboratories necessary for his course requirements. He explained that he wanted to have readily available access to all of the technology he wants to work with but because he often shares the classroom with another teacher, it would have to work for them as well. This was one of the barriers. Another barrier was the fact that technology is forever changing. He felt that as a newer teacher, it was going to become harder and harder to stay ahead of the updates and new versions and to not get swept under by the wave of the ever-changing technology environment. He hoped that he could keep up with it enough to continue to use it, but without support, he feared it may be too challenging.

Carl believed that if he were to look back to three years ago and compare what he does now in his classroom to what he did before, he felt that he has a much stronger understanding of using technology in the classrooms. He admitted that he does not always have the answers. He explained that he uses his students' wealth of experience and skills to learn and fine tune his own. There was a disadvantage to this type of technical support. He explained that when he gets stuck or needs to troubleshoot something in class, he asks his students for help. Sometimes they can help but sometimes they lose patience: "everything is so immediate nowadays... when they're stuck they shut down really really quick as opposed to trying to figure it out on their own". The fast-paced capabilities outside of the classroom may pose a challenge when asking students to engage with potentially slower network connections.

Advice to Teachers Wanting to Integrate

When I asked Carl to give advice on how to integrate technology into the classroom, he said: “I think the unfortunate advice is that it will be frustrating in certain cases and I don’t think the support is totally there.” For a teacher who is determined to integrate technology into their classroom, this advice may not alter their drive. For those teachers who may still be hesitant, the “just hang in there and figure it out” could feel overwhelming and discouraging. Carl suggested that teachers search out experts within their schools and ask them questions. He warned that one must remain conscious of the fact that there may be only limited knowledge and also how much time one wants to spend on acquiring the knowledge and skills. He went on to explain his caution:

You might be able to make a really good lesson but if it takes you a massive amount of time to do it, there needs to be a balance so you may not be able to do it.

There are many demands on a teacher’s time, so expecting that there will not be struggles is unrealistic.

Ahead of the Curve

Although Carl identifies himself as a newer teacher, he can still identify the areas in education and the classroom where technology fails. Throughout our interviews we discussed the

common notion that there are problems when trying to get technology to work and function the way it is supposed to or the way you envision it. For Carl, one of the ways that he saw himself standing out from other teachers who are not integrating technology into their practices was that he believes he has an individual ability to problem solve and troubleshoot to make it work. He shared that these skills could be factors that help him so that he does not give up. His drive to not give up acquiring technology knowledge and refining his skills was propelled by his belief in the value he sees in differentiation abilities technology brings to his classroom.

Carl proposed that usage of technology comes down to ones own comfort level. Carl preferred to use technology. He was part of the younger generation of teachers who grew up with technology, “I grew up with computers so it’s not that foreign of a concept”. For some people, he added, trying to use computers may be a foreign concept and with the rate at which technology is changing, it is understandable that it can be frustrating. Since he grew up with technology, Carl assured me that he could easily adapt to these changes.

When it comes to Carl’s role in the classroom, I asked him whether or not his role had changed as he has become comfortable with technology. He told me that his role in the classroom depended on what he was doing and how he was using technology. He described two roles. The first he described as a modified *direct-teaching* role. He explained that he takes on this role when he is using a demonstration or a physics simulation because he explains what his students are seeing, “the computer is showing that visual aspect and you’re kind of the voice talking about it”. The second role was more of a *facilitator of discussion*. He would take on this role when he is sharing a video or when using Clickers⁴ where he is asking questions and having

⁴ Clickers are an interactive technology that enables instructors to pose questions to students and immediately collect and view the responses of the entire class.

a discussion afterwards. Taking on these different roles helped Carl to respect the value technology has to differentiate learning by meeting the needs of his students.

Hopes, Fears, and the Future

Since Carl was a newer teacher and had built up his comfort level with technology, he told me that he does not have any major fears about incorporating technology into his teaching. He explained that technology is everywhere; “there is an expectation now for communication.” Continuing further with the interview, he admitted that he was worried about the time commitment and that he doesn’t see it as “do or die” because he feels there is no choice and that you learn to function with the time. He also mentioned that he was concerned that the quality of the professional development workshops that are provided to teachers was not helping to build confidence, “if you ever go to a Smart Notebook workshop, they show you how to open it, how you draw on it, how you write on it...”. When follow-up sessions were not provided to help teachers develop their skills, Carl believed that some of those who were trying to use technology would not see the general-level workshops as useful.

When explaining his best hopes for technology in his teaching, it came down to time. Carl explained that his hope was that by using technology in his learning, he would free up some of his time. He also hoped that by using it to its fullest potential, his students would learn better. He hoped to be able to balance the time it took to master technology for the success of his students with the need to disconnect outside of the classroom.

When describing his future classroom, Carl believed that technology would become a constant tool in the classroom:

I think eventually you're going to get to the point where tech should be somewhat integrated into your classroom.

Technology is becoming commonplace in society and is a large tool for the way students communicate, and teachers will have to embrace it, even in a minimal capacity, for the success of their future classroom. Once you get a piece of technology and figure out how, where, and when to use it, Carl believed you will be able to run pretty seamlessly. He warned that it could be time-consuming, but that it was the front-end learning of how to use it in your classroom that takes up the most time, and once you become comfortable with it, you will become faster and it will be simpler to integrate into the classroom.

Lindsay's story.

School Life

At the time of this research study, Lindsay Jackson, aged 35-44 years, was teaching grade 10 applied Science, grade 11 International Baccalaureate (IB) level Chemistry and Biology, and grade 12 university level Chemistry. Her school was the only school in this study to be non-semestered. Her school had over 40 years of excellence in academics, athletics, and the arts. Over 50% of the students enrolled in the school were registered in the IB program, a world-renowned program for highly-motivated academic students who wish to earn an IB diploma in addition to the Ontario Secondary School Diploma.

Acquiring the Necessary Knowledge and Skills

As Lindsay's narrative indicates, one's life experiences can also have an impact on how skills and knowledge are acquired. Lindsay shared her very interesting and perhaps uncommon early exposure to technology. "My mother is in Robotics. So I grew up exposed to computers and technology earlier than many people of my generation." This early exposure to technology allowed Lindsay to acquire more knowledge and skills with ease:

I have never really had a fear of technology because I had such exposure to it.

When I hear about things in the media or from the students that I find

interesting, it's been more asking 'hey, can you tell me more about that' or 'I'd

like to find out more about that'.

This level of confidence with technology put Lindsay at an advantage when it comes to using and integrating new technology into her classroom.

Time for Integration

Unlike other participants, Lindsay taught at a non-semestered school. With her 5 – 14 years teaching experience and over seven years of experience using technology in the classroom, she was at a comfortable level in regards to her usage. She told me that there is always a time-investment need and without it, there is a chance to become complacent or unwilling to change. She shared her newest ambition, "I've started this year narrating videos of PowerPoint lessons

for my classes and then posting them.” As you can imagine this would be time-consuming.

Lindsay said that she spends over 10 hours per week using technology in her teaching practices.

She acknowledges that:

it's pretty time consuming and it's mostly on my own time and I'm looking forward to having a more complete set of those completed and ready to go so it's not like every night I'm going home and I think 'oh I have to create another video' to keep up with it.

She was driven to continue narrating her PowerPoint lessons because (once she posts them to her class folder) if somebody misses the class they can watch the video instead of just getting notes from someone in class. Her videos contain audio so they can hear her explain the material.

Advice to Teachers Wanting to Integrate

Like the other participants, her advice to technologically novice teachers was to jump in. She urged to:

Do what you are comfortable with. Don't feel that you need to do it all at once. You know, pick one thing that you're going to really try to do a good job with one year and then the next year, you can always add something else.

Her urgency was due to the fact that it takes time to integrate technology but you need to feel like the investment of time is worth it. Lindsay believed that there was a payoff to student

learning, especially because students have grown up with technology and they are comfortable with it. She also believed that if we are not using technology then we are missing a possible connection we can make with our students.

Ahead of the Curve

In the classroom, Lindsay saw herself as a facilitator. She shared that she tries to limit the amount of time she spends lecturing and conveying information and increase the time she spends engaging the students with the material. Lindsay also described that she was trying to facilitate her students' learning even when presenting a video to her class:

It is pretty rare that I would just play a video and, you know, just sit back and have a little nap myself. Mostly, I'd be maybe stopping it at some point and saying 'did you catch that?'

Engaging her students with the material was important to Lindsay. Her experiences helped motivate her to want to change the way she incorporates technology in her classroom.

Hopes, Fears, and the Future

When I asked Lindsay what her biggest fear was when it came to incorporating technology into her teaching, she told me that "I would hate to invest a lot of my own money in particular in say, hardware, that then if it were to be damaged or unusable in the classroom I would lose that

investment.” She feared that she would be making a personal investment that she wouldn’t be able to get back.

Her best hopes for technology was that it will spark something in her students and will allow them to catch interest in a topic. She hoped that technology would help to enhance her students’ learning and “make the fact that they have to come to school every day a positive experience and that they would see the connections in their everyday lives.” Being able to provide her students with the opportunity to make these connections would go a long way to enhancing student learning. Lindsay also hoped that she would be able to stay current in terms of her professional development so that she could remain up-to-date for the benefit of her students.

Lindsay believed that our use of technology was only going to increase as she reflects on how much things have changed in the last 10 years, “there is just so much available that it’s not going to go away as new generations of teachers come in who have grown up with technology.” Lindsay told me that she thinks the future classrooms will have more comfortable teachers:

I think we’re going to see more generations of teachers who are comfortable and very naturally bring in new technology and are eager to learn and feel comfortable with them.

She believed that there will come a point where there is less of a need to push teachers towards incorporating new technologies and that it will be the new norm.

Oliver's story.

School Life

At the time of the interview, Oliver Godrich was a teacher aged 55 and over. He taught grade 11 and 12 university level Physics and grade 11 university level Chemistry. His school offered a semestered program from grades 9 to 12. Their foundation was a strong academic program built upon its core disciplines of Science, Math, Canadian and World Studies, Technological Studies, and English.

Acquiring the Necessary Knowledge and Skills

Similar to many of the participants, Oliver acquired his working knowledge of technology and the skills necessary to use it on his own. He had not attended many workshops. In Oliver's Physics classroom, he used a number of Java applets that he found and practiced with on his own. He told me this is mainly due to the limited workshops available to him, "only once every two years you get a professional development activity related to something to do with the Internet or a specific program you can use in your classroom". He also remarked that in the past he would make his "own little animations on acetate sheets and moving them around." It was just so stupid compared to what you can do now. There's just no comparison". At the rate technology is changing, the advances that fascinate us today will be surpassed by those of tomorrow.

Oliver had been teaching for over 25 years. In that time, he had been using technology in his classroom for over seven years and used technology in his teaching at least 10 hours per week.

This had grown through the use of the Internet and Internet-based Java applets and sometime virtual labs that he could manipulate using his classroom Smartboard. Oliver described his teaching strategy with technology as useful to his teacher-centered lessons, although stated that some online simulations and virtual labs were less useful than others. Oliver was a strong advocate for the use of Smartboards in the science classroom:

I run simulations on the Smartboard and that is a huge part of my lessons. It's almost every lesson where there's some kind of simulation being shown . . . It's so useful that I can't even imagine teaching without it. If I didn't have that, I'd be thinking 'wow' I'd be doing a second rate job'. So, I think that every science teacher should have a working Smartboard in their classroom.

Oliver admitted that most of the Java applets that he used in his classroom had been designed for university, like the PhEt Simulations from the University of Colorado, but he had been able to adapt them to the high school level. Another useful aspect of being connected to the Internet through the Smartboard, he told me, was that when a student asked a question and he did not know the answer, "I say, 'Well. I don't know. Let's look it up.' We'll just look it up right then and do it up on the screen and everyone gets to see it. That's fantastic." From his experience, he concluded that students are more engaged when he is using technology or when he is involving them more when using it.

Time for Integration

For Oliver, the infusion of technology into our teaching was a goal that is somewhat unobtainable because of the constraint it places on a teacher's time. It is important to note, that at the time of the interviews, Oliver was two months away from retiring from his full-time teaching profession. Despite having only a few months left of his teaching career, Oliver was still investing the same amount of time in his preparation and craftsmanship with technology up until the last day, as he had on his first day of teaching. He explained to me that:

One particular simulation you could spend two periods on and really it's a half-a-period lesson. So that is four times longer than the (time) necessary for it... we don't have the time.

He believed that there were many online simulations and activities available that teachers should be able to do, but teachers do not have the time to get the students to go and explore all the different avenues. Oliver also shared that the process of infusion was not something that just ends. As technology was developing and changing, there were new factors that need to be explored and adopted for classroom usage and it would take time again to infuse them into everyday lessons.

Advice to Teachers Wanting to Integrate

With over 25 years' experience behind him, Oliver shared his advice to those teachers who

have a desire to begin the process of including technology in their instruction. He started by advising that they need to just start using it. He urged that “you cannot listen to somebody tell you how to do it... and then maybe try to figure it out by listening.” The only way, he told me, is to do it yourself. He feared that this may be what stops some from trying.

His next piece of advice was that you need to play with it on your own time and before class. Like in science, “anytime you’re doing something like your science labs, you always have done them before you tell the kids how to do them so that you know how to do it.” That same thing can be applied to technology, “so there are times when I go into my classroom after school or at lunch and I’m just playing with the Smartboard.” This is how he prepared and he advised other teachers to do the same.

The final piece of advice was to not expect that things were going to work out the first time, and he stressed again that it needed to be practiced. He wondered whether or not this is a particular attitude. As a physics teacher, he had many resources that do not always work the first time and require a degree of troubleshooting. Even though we are now dealing with electronic technology, the attitude, in Oliver’s opinion, was still the same: make sure it is working before the class starts.

Ahead of the Curve

One of the ways that Oliver saw himself as different than those teachers who are not integrating technology into their instruction was that he does not get frustrated when things don’t work out. He shared that when things do not work out the way he wants; he tries to look for different ways to get it to work. He believed that this may be the reason why some do not use the

technology, “you’re always going to come across things that don’t work for you... you get frustrated and you just give up on it.” When this happens, Oliver suggested that reaching out to another teacher or a tech staff member was a step towards addressing or eliminating any frustration. Since Oliver had a vested interest in using his Smartboard and simulations daily, he was not afraid of troubleshooting certain glitches himself until he gets it to work; he was also not afraid to call the tech member on staff to help him troubleshoot an issue.

When speaking with Oliver, I asked him if using technology has changed the way he teaches. Fascinatingly, he shared:

You know what I do say to people, technology has completely changed the way I teach. The question is how and that’s a harder question to ask. It’s just you know, like for example, I can’t imagine going in to teach my class without my Smartboard.

Oliver was a strong advocate for using technology to its fullest potential in the classroom. He explained one experience in particular that stood out. A year and a half ago, Oliver traveled to Australia on a teacher-exchange program. He was teaching intermediate level math and science, physics, and a few other courses. Every classroom at his school had Smartboards but none of them worked. No one was using them as a Smartboard – they were using them as projection screens; no one was using them to their fullest potential.

While teaching in Australia, Oliver was teaching courses that he had never taught before. Since Oliver had over seven years’ experience using technology and had a Smartboard in his own classroom back in Canada, he was eager to use the Smartboards as Smartboards - to

integrate the different applets and simulations into his lessons because it was easier to get the students more involved. Oliver spent more than 10 hours per week using technology in his classroom “I think that if you took, I mean, if you say ‘how does technology change the way that you teach’, well, just image what you would do without access to computers or the Internet and it would be ‘Wow. I wouldn’t be able to function’, so yeah, it’s completely changed.” Using technology changed the way that Oliver structures and presents his lessons.

Unlike the other participants, Oliver viewed his role in the classroom as one of two options: “one is I’m using it to facilitate a teacher-centered lesson and the other way is to facilitate a virtual lab – a student-centered lesson.” When his focus with technology was on his students, he described his role as a support for the students; he was there to answer questions. When his focus was on himself as a presenter, he believed his role was to impart information and skills to his students.

Hopes, Fears, and the Future

While speaking with Oliver, it became clear that, as a strong advocate for the use of technology in the classroom, he still had a true fear that we may go too far in our integration. His worst fear was that we get to a point where all of the teaching is done online and that teaching would become very impersonal. This was a strong contrast to the paperless classroom Brendan dreams of. Oliver explains that:

My worst fear would be that the whole thing moves towards a completely impersonal style of learning. The group learning thing has some benefit, but

it's not the be-all and end-all. I don't believe that we should all be heading towards that way.

He felt that this was where people wanted to go. He feared as well that he would start to lose control over how the content was delivered. He shared that he did not use technology outside of the classroom. He did not have a website set up nor did he use his email outside of school hours to communicate with students. Perhaps this is how he chose to remain personally available to his student because they must communicate with him during school hours.

His best hope for technology integration was that the students embrace the technology themselves. He explained that he does not believe they embrace technology in terms of the learning process. Many students are surrounded by technology in most aspects of their lives. He felt that students should be using the technology to help them learn as they move through their education but that they still relied on the teacher to feed them everything. He gave me an example of the Java applets he used in his class:

The kids don't use them on their own. They would use them if I gave them a directed learning activity; they would do it. But they don't actually get on and experiment with it and do it themselves to see what they could learn.

His hope was that his students developed and understood that learning while experimenting or playing with a simulation was how they would learn.

When I asked Oliver what his future classroom would look like, he told me that he would like to see students, all students, having a personal device of some kind, not just a cell-phone

because they are too small, that they could interact with the Internet and interact electronically but at the same time interact with the teacher at the front of the class. He explained further that his ideal classroom would have a:

Smartboard at the front for me, and the students would all have a laptop or an iPad to interact with the Internet, and the Wi-Fi works perfectly, and there are no restrictions on the sites we go to and the speed of the server has to be appropriate.

Speaking about possibilities and complexities of security concerns, Oliver believed that securities are so high in his school and on the board network that the devices and other technology become unusable.

Once every student has a personal device, Oliver would like to see the employment of technologies that do not depersonalize the learning experience, but enhance it. He would like to see the use of technologies like Clickers to interact with his students and gauge their understanding. He believed that the anonymous and statistical nature of these devices may also appeal to the quieter students in his class, “40% of you think this, 60% of you think that, now let’s have a discussion”. He pointed out that this type of polling lesson is the kind of lesson he used often with his students. Being able to survey all of his students at once instead of individually where students may be influenced by their classmates, was a benefit of this growing technology. Oliver’s future classroom would be interconnected with clickers, personal devices, and his Smartboard, while remaining a personal learning environment.

Randall's story.

School Life

At the time of the interview, Randall Marshall, aged 45-54 years old, was a teacher and Science Department Head. He taught grade 9 and 10 Science, and grade 12 Biology. His school offered a semestered program from grades 9 to 12 to approximately 1035 students with diverse ethno-cultural backgrounds. It had been recognized as a leading school in Canada in the use of information technology in the classroom. His school offered a Specialist High Skills Major (SHSM) program designed to let students focus on a career path that matches their skills and interests while meeting the requirements of the Ontario Secondary School Diploma. They also offered various school programs involved in the creative use of technology.

Acquiring the Necessary Knowledge and Skills

Randall's experience with technology started in his high school years. During high school he was interested in technology and took computer and programming courses. He also surrounded himself with like-minded friends. He shared that they would create games and talk about things on the computer. Throughout high school he would also read computer magazines to keep up-to-date on what was current at the time. Nowadays, he added to his knowledge and skills by learning from his students. He found that by speaking with his students, he learned about what they are involved in and what is going on in the current technology landscape.

From the start, he used both Apple and PC platforms. He felt this was important because

this flexibility allowed him to recognize what was available on both platforms and what he could use on each. He shared that when he received his first major teaching job in 1993-1994, the Internet was available but not in the form we know it today. Shockingly, there was no World Wide Web, but there was Internet use. At that time, he got into emailing and got all of his students free email accounts and he started using the Internet to send emails and simple searches - nothing like the searches you can do with Google now.

For someone like myself who can only vaguely remember a time before Google, Randall brings a wealth of experience. As his experience with technology and the Internet grew in the late '90s, he started to get more involved with the Internet, using web browsers, and using e-learning systems like Blackboard (which is still in use today). When the school board began using the Blackboard platform, Randall was able to integrate its use into his classroom to share information, facilitate discussion, and as a method for his students to turn in work. His experience and understanding of technology also allowed him to complete his marks online and share them with his students and parents confidentially.

Time for Integration

Technology has come a long way since the 1990s. Interestingly, even with Randall's background knowledge and experience with technology, it still took him some time to infuse technology into his teaching. He explained that he started by bring what he could to class. He found that once he got things to where he wanted them to be, things would change or certain software wouldn't be available anymore. Technology changes rapidly and there are numerous education platforms that could be beneficial to learning. Randall explained that not all of them

are equal:

When our school board switched from Blackboard to Desire2Learn, another learning management system, I used that one for a couple of years but I didn't like it. I felt it was very controlled.

Like devices, not all learning systems are made for all teachers. When the school board made the transition to Google, he didn't like how it was set up. He spent many hours adapting his notes to this new platform and had to switch everything again. Due to this frustration, the lack of freedom of the Desire2Learn, and personal preference, Randall told me that he has moved away from these platforms and started to use Schoology. This learning management system allowed him to have more control and freedom over what he could share and how he interacted with his students. He was confident in the process and the time investment because "I am interested in doing it. I will make it happen, but it doesn't happen right away, it might take me a year to develop it the way I want it". For those who are resistant to change, he believed, it may take them four or five years to start.

Randall analyzed the time commitment by explaining that when he was trying something for the first time he tried to develop it as he moved through his first semester and that by the end of the next semester it would be where he wants it. In his second year, he added to it. He admitted that this was a continuous process because software becomes unsupported or the board introduces different software they want their teachers to start using. He explained that the constant changing can get, "kind of frustrating when you have something working the way you like it to, and then something outside of you changes and you've got to find a way to deal with

that.” He dealt with this constant fluctuation of changing platforms by working with and controlling what he can whenever possible. He told me that he often has backups of his information so that nothing is ever lost.

With a long teaching career behind him and new technology in front of him, Randall has needed help along the way to adapt his old resources to the new platforms. He shared that he spent time converting his VHS resources onto a digital format:

I took a year to get some of those tapes transferred over and that’s because I found other people who were able to help me do it. If I had to do it all myself, it probably wouldn’t have happened for five or six years.

He also sometimes received help from his students. He told me that he would give them a project where they would have to do something that would help him and in the end it would also help them. One project in particular was getting his students to transfer his notes into a digital format. Asking for assistance from colleagues and students helped Randall address some of the time constraint.

Advice to Teachers Wanting to Integrate

The first step for those teachers who have a desire to begin the process of including technology in their instruction was to “start”. Randall advised that you:

Identify one thing you want to do. Make it one, make it simple and start doing it. And as time passes, it will become what you want it to become or you find

that it's not what you want and you can switch to something else. So at least you start, at least you're trying something and it will grow from there.

The next step was to “*Get others involved*”. Randall urged:

If you can share what you're doing with someone or other people, then you can learn together or you try to look at more than one thing. One person can try one thing, another person can try something else, and you can decide together which one's working, which one's not and you can decide that way a little faster.

Randall went on to tell that when he started to use Schoology in his classroom, he then shared it with his colleague and his colleague started to use it too. As his confidence grew with the platform, Randall shared it with more of the staff at his school and he thought that some people were going to start to look at this platform as an additional tool for their own classroom.

Ahead of the Curve

One of the major ways that Randall felt he was different from his colleagues was his willingness to try something new. He explained that if he was interested in a particular tool and he felt it would help, he would try it. If he felt it was not going to help him, then he was less likely to try it. Randall believed that even for the teachers who have been teaching the same way for many years, if they saw something new and they saw how it could help them, they would

probably try it. Technology may not be for everyone, but everyone deserves the opportunity to be exposed to it and to make that decision for themselves.

Randall told me that he was always learning new things. Intriguingly, he did not learn through the traditional manner of researching on the Internet or reading magazines. Instead, he focused his learning on those around him. When he talked with his students, or shared with his colleagues, or was asked for assistance, these gave him ideas. He explained that “my role in the classroom is to try to tap into some of the expertise out there already and see what they’re using.” Being open to embracing his students’ experiences helped Randall to learn more rapidly through word of mouth than spending time research on his own.

Hopes, Fears, and the Future

Randall confided in me that his worst fear about the process of incorporating technology into his teaching was that he is not given the flexibility necessary when choosing how to integrate technology. He feared that the school board was trying to control which technologies teachers were allowed to use. He explained that:

A couple of years back we had to change the software we used for taking attendance and there were some glitches with that and the board had to go back and they ended up finding another way to do it for us that was easier.

Randall did not like the feeling of being forced to do something. When there were limits being put on what teachers can and cannot use, it caused him concern. His concern seems

justified because if he were to become reliant on a particular type of technology and it becomes unavailable, the time and effort that he put into learning would have been wasted. Change is sometimes necessary and Randall said that he would keep looking until he found something that works for him but that he must be the one that was in control.

Randall's hope for the future of technology in the classroom was for the board to provide funding for schools, departments, and teachers to purchase the technology they want to work with and to help to keep it up to date. As the Science Department Head at his school, Randall's job came with a set of unique responsibilities. Randall believed that the onus should not be put onto the teachers to keep resources up-to-date with their own money. Ultimately, Randall explained, it comes down to resources:

I just want to have money or have access to resources that will keep us, maybe not 'up-to-date up-to-date' but, within a couple of months, or six months, or within a year at least of the technology.

Unfortunately, Randall told me that the resources and software they are using now are so old that even with the latest updates, they are so far behind current technology that they would not make a difference.

As a department head, he realized that if money was spent in one area, then it was lacking in another. His school was not spending money on updating his science equipment to the newest digital sensors because they were spending it in other places, "I mean, maybe every year I can add another sensor, and maybe in five years I'll have enough for 10 people." In his opinion, money was a big concern. Having enough money to have the tools to do his job to his fullest

potential was Randall's best hope for the future of technology in the classroom.

Randall envisioned his future classroom as a combination of the regular classroom mixed with technology. He saw this as more realistic. His reasoning was that despite having a complete e-learning model, it took a very select group of people to make it work. To accommodate everyone, we would have to have a little technology mixed with the regular classroom:

I think it's going to continue to be a mixture and my only concern with that is there might be an obligation that teachers be available 24 hours to deal with questions coming at them.

He believes that it is going to be a blended learning environment. Guidelines for teachers and the ability to disconnect from their environment may be a necessary option.

The purpose of sharing the lived experiences of these teachers who use technology in their science classroom was to uncover the real time glimpse into the lives of teachers who were using technology within their classroom. Through their stories, we gained a snapshot of their experiences and can potentially relate to their successes, frustrations, hopes and fears, and learn strategies for our own practice. Each teacher had their own unique experience, perspective, story and advice. Collectively they shared wisdom and experiential insight into teaching with technology. The following section elaborates on the themes which resonated throughout their interviews.

Chapter 7: Analysis

Qualitative Themes

Secondary research question findings: A synthesis of narrative themes.

Introduction: Staying close to the truth-tellers' stories

As explained earlier, my qualitative data was built on the quantitative data of this thesis using the methods described by Creswell (2013) and Ivankova (2006). The quantitative results provided a beginning framework with which to understand the perceptions of technology usefulness and ease of use of these participants. Here I developed a scale to quantify my research question and study participants obliged by ticking the boxes that most approximated their experience, as dictated by me and the research. When I closely analyzed the secondary research questions, different sets of themes emerged and these are the focus of this chapter. This chapter elaborates upon and extends the qualitative data. This chapter used Bruner Functional approach to Narrative theory. Interestingly, the themes that emerged emphasized a more nuanced teacher experience. The themes presented here are an extension of participant's responses and has attempted to not leave anything out or bias the data. It is a long and intricate amalgamation and because of this, I feel that it is important to give these themes their own chapter without initially comparing or analyzing them to current research.

Secondary Research Questions

I. Specific limitations and constraints perceived as affecting attempts to incorporate technology into classroom.

I have classified the limitations and constraints expressed by these participants under four subcategories and then elaborated on each: i. Technology Limits and Glitches; ii. Teacher: Personal and Professional Limits; iii. Student Limits and iv. Practical Limits. While lack of training and support were alluded to, these topics came more into focus when participants discussed their wishes, and so will be explored into in section three, Necessary Supports.

Technology limits and glitches.

Technology limits have been subcategorized into (a) Hardware, (b) School Board Hardware and Infrastructure and (c) external.

Hardware.

Participants reported a variety of difficulties with system hardware. Specific issues included:

- Network access
- Start up glitches
- Slow and old computers
- Cable connections problems
- Log-in failures
- Failed or broken computers

- Lack of equipment

An ongoing concern was with technology being too slow and old or having connection troubles that the students got frustrated and opportunity for learning were lost. Two participants spoke of computers which were 10-15 years old. Old machines posed problems in terms of reliability, speed, ability to save and combine data, and troubles occurring through multi-use (computers are used by many students).

In one odd exception, one participant spoke about the underutilization of Smartboard technology, explaining that most people he spoke with regarding Smartboards just used them as projector screens because they got too glitchy and the classroom teacher had not been trained on how to fix them. He felt this was a waste of money.

School board hardware and infrastructure limits.

In this study the participants all commented on limitations of implementing technology at the school board levels, these included issues related to:

- Infrastructure – wi-fi, firewall
- Operating systems and upgrading systems – Google platform, difficulties with curriculum requirements matching with technology platforms
- Policy restrictions – limited course application meant cost prohibitions, policy restrictions that are argued are for security reasons, permission protocols
- Budget restrictions
- Learning initiatives on PD days –limited, infrequent, basic level.

All of the participants understood the constraints that the school board is under. It is a large system with multiple overlapping areas of concern. In some ways this age of technology is a new frontier and traversing it is an exercise in learning as you go at micro (teacher in the classroom) as well as macro (school board) levels. The two participants who were department heads at their school reported that there were obvious ongoing financial constraints and budget shifts which limited acquisition of hardware and technology as well as upgrading of equipment. Competing needs from departments meant that the school board didn't want to provide something because it was too cost prohibitive or delicate or if it would only be applicable to a small number of courses. All participants spoke about infrastructure issues such as wi-fi access which was sometimes unreliable and entirely lacking in some schools. Some school boards have placed restrictions on full access over the Internet through firewalls. While these were meant as protective measures (against viruses as well as student access to unsavory Internet portholes), these firewalls also restricted access to useful teaching tools, programs and learning information. On a positive note, the school board had allowed access to YouTube over their servers but the process of gaining access to all teachable information was time-consuming and frustrating.

Many participants focused their comments to some extent on the bureaucracy and policy frustrations. One participant, a department head, spoke about recent constraints with the school board making everything standardized such as specific brands of technology as well as board policies that necessitated clear rationale and board approval for the submission of equipment requests. It was noted, however, that it takes time for bureaucratic decisions to be made or for bureaucracy to adopt changes. Additionally, the issue of platform universality was a conundrum for many of the participants. Historically there have been a variety of idiosyncrasies that come with using different operating systems, according to one participant. Also, when the school board

upgraded its protocols (for instance, by adopting a Google platform), the transitions was tricky. The school board was becoming more open to students using their own devices while ironically limiting teachers by insisting on universal equipment.

There were also issues with the classroom curriculum not easily jiving with technology platforms. All participants found ways of managing this however. As a point of interest, technology has come a long way and yet we remain on the threshold of development. Oliver noted that there were not as many opportunities to use simulations in some subjects because online availability was limited. Lack of support through continuing education and PD days is explored in section three under Necessary Supports.

External limits.

Two participants described technology issues related to big business and society concerns. These included: Universal blackouts and brownouts; Internet provider problems; Expert external specialist support needed but unrequited.

Two participants focused some attention on limitations related to technology that we all (as a society of technology users) have experienced: The Internet being at overcapacity or slow and universal blackout, which can be frustrating. As well, there were times when external specialist support was needed in a timely way but was not accessible.

Teacher: Personal and professional limits.

In this study all participants reflected on their own personal and professional limitations. These were categorized roughly into three themes: a) practical self-constraints: lack of time, lack

of knowledge, technically un-saavy (can't fix minor problems), limits related to spending personal money because of lack of school resources, software upgrading pressures; b) self-experience constraints – anxiety and giving up prematurely, self-reliance, and isolation; and c) school life – lack of collegial support and knowledge, multi-user computers where other teachers change settings, multitudes of platforms.

a) Practical self-constraints: I defined these as real (in the world) practical difficulties that participants experienced as they attempted to use technology. These are real-time pressures or forces from their external environment. Here participants described their experience with the external pressures they perceived. Time restrictions placed a risk on how much could have reasonably been accomplished during a single classroom or preparation period. Many participants faced decisions about how and when they learned about the technology, how and when they implemented it in their classroom, and how much to invest in staying current. Most described the personal investment of money for technologies they deemed helpful to their teaching. This also posed barriers due to their personal financial commitments. They all described considerable investments and constraints on their time outside the classroom to accomplish their goals. Many participants also discussed their lack of substantive technical expertise as limiting when fixing problems and helping students.

b) Self Experience: For some, they developed a tendency to work in isolation and developed a self-reliance. While this moved them forward, self-teaching was a longer path to mastery than having mentors or other traditional learning paths. For others, these limits undermined their confidence, and resulted in anxiety and frustration with themselves. One participant realized a propensity to give up prematurely (and saw this in other teachers trying to adopt technology) and

had worked to shift this reaction. Most described the fine line between their tenacity, their realistic skills, and time constraints. Another participant labeled his experiences as ‘tuck and roll’ where ‘every day is a new adventure’.

c) School Life: Additional limitations described by all participants were general experiences that were beyond their control. These experiences included a general lack of collegial support and know how. As well, there were few mentors to help, support and brainstorm with these participants. This limited the sharing and development of ideas. One participant wished that more teachers would buy into the technology and that the science department would take a leading role with this. One important anomaly was discussed which has relevance to the incorporation of technology and its downside: a concern about the limits of computer simulations, more specifically, that computer simulations might take the place of real-life experiences. This can be seen in the general public as people watch television or play computer games or take selfies at the expense of true engagement in life. It seems true that technology, with all of its promise, can modulate and thus ironically limit reality.

Student limits.

Each of the participants spent time talking about their attempts to integrate technology and the response of their efforts on their students. By and large, students enjoyed and benefited from working with technology but at times there were difficulties. These included: student resistance and difficulties with adoption, students getting bored, students using their own devices (so a lack of classroom cohesiveness), students being at different levels of technological expertise or interest, complications with dynamic changes in the classroom with teachers’ need for

collaboration; and need to use some students as in-classroom tech help or mentors (while other students wait and become disenfranchised). As with many things, aspects of these changes were beneficial for some and limiting for others.

All participants described trying to find ways to get students to self-initiate and experiment with technology and science applications or simulations from: invitations to students to bring their own devices into the class, to innovative lesson plans and computer applications, to computer labs available and teachers making themselves accessible.

Practical limits.

All participants discussed many practical constraints including: a) class related issues: classroom transiency, physical space, time, and equipment, reductions in the number of landlines, limitations on students using personal devices; and b) support issues: defunct online support communities, too quick implementation of technology without enough training, technical support limits

In all aspects of life, the ‘ideal’ always bumps up against the constraints of reality. It was no different in the classroom for these participants. Planning lessons and then negotiating their implementation was a skill unto itself and each participant spoke openly about some of these constraints.

a) Class related issues: One of the most common areas of concern was issues around physical space and equipment constraints. This included:

- classrooms as multi-functional spaces which caused availability issues

- teachers being assigned to different classrooms which created constraints on the reliability of equipment
- cuts to the number of landlines required for Internet access available within some schools
- limited access to shared technology equipment such as multi-teacher usage and abuse issues
- limitations on teachers bringing personal devices, which, if policy was changed, may increase ease of use.

As well, when students used their own devices which can utilize different platforms, life got more complicated in the classroom. This allowance required additional support.

b) Support issues: There were limitations with technical support which were a concern for all participants. This included money for external specialists who could fix specialized equipment such as Smartboards. Many participants reported school board technical support having limits in their knowledge, and technical support not responding to classroom glitches in a timely way.

Many participants explained that there had been attempts at online support forums in the past but these were underutilized and became obsolete, leaving a gap in potential mentorship between teachers.

Support comes in many ways and this section has focused on its technical aspects. Each participant spoke clearly about issues related to technology-focused Professional Development (PD) days, which are perceived as limited, infrequent, and for the advanced user too basic. Many

also spoke about risks to integrating technology too quickly or too blindly. These issues will be addressed under section three, Necessary Support.

One final note, for each participant who had embraced technology was the concern is that if appropriate and ongoing support was not forthcoming, other teachers would lose their initiative to implement technology in their classes. They hoped that this will not be the case.

In conclusion, when discussing limits to implementing technology, many participant responses included struggles encountered with the technology itself, with school board support, with student response, and with personal barriers and practical restrictions. In spite of constraints around technology implementations, each participant remained optimistic and steadfast in embracing change and being on the forefront of teaching innovation.

II. Specific teaching strategies perceived as successful when incorporating technology.

As a young teacher myself, this section of the study was of particular interest. I sometimes found myself engaged in reciprocal exchanges and ideas. This example of novel approaches to projection illustrates issues of spontaneous collegial ideas exchange, creativity and barriers.

Me: "... you can do a projector with your phone with just a shoe box and a magnifying glass." Randall: "Ya, I've heard about that but I haven't had time to investigate that yet.... I've also heard you can take your Wii motion detector things from the Wii devices and turn your chalkboard into a Smartboard. With a projector and your computer, you could turn it into a Smartboard." Me: "Oh, I haven't heard of that one. I'll have to look that up." Randall: "I haven't tried it yet. It'll cost you \$100 to do it though."

Each participant spoke directly and indirectly about shifts in their teaching strategies when using technology. It became obvious that there was a reciprocal relationship at play: while these teachers proactively adopted teaching strategies to incorporate technology into the classroom, their teaching strategies were also retro actively shaped by technology use. Various themes emerged through the interviews and have been classified into the following sections: I. Attitude: technology as shaping teaching attitude; II. Shifts in teaching orientation; III. Classroom management and teaching strategies; IV. Practical management strategies: of in-classroom glitches; V. Successful technology applications and tools; and VI. Participant-observer Strategies (strategies developed based on observed in-class feedback).

Attitude: Technology as shaping teaching attitude.

All participants spoke about ways that they were *different from the teachers who were not integrating technology* and how technology had shaped them. They discussed issues of attitude including: attitudinal tenacity, problem-solving abilities, technology as a preference, active decisions to change their teaching style, embracing change, recognition of the long-term time benefits of technology, and embracing remote connection.

All teachers are charged with the professional responsibility to solve problems on the fly; it just comes with the daily functions of the job. When it comes to technology, all participants described a *tenacity* in regards to their attitudes towards technology, with phrases like ‘trusting my ability to problem-solve, not giving up, not getting frustrated or being afraid, plugging away until it works, trying to look for different approaches’ etc. One participant pondered this problem-solving propensity, wondering if science teachers (given the nature of the topic) had

more proclivity than other kinds of teachers or whether it is a male or female ‘thing’, novice teacher vs experienced teachers, or a personality thing, it’s something hard wired’. Another also thought it is part of personality (how you look at life and a reality-based attitude of trying the best to work with what’s happening).

While one described an active decision in wanting to change the way she practiced, another’s attitude seemed more organic, based on growing up with computers and simply having a preference for using technology. Each participant described an openness to embracing change, an ease with adapting, and a willingness to try something new. Attitudinal stances also appeared in discussions of the long-term time benefits of adopting technology versus lesson prep time, as well as the preference of remote connection (especially the ability to do work at home).

Each participant spoke about their preferred connection to technology with phrases like: “technology has completely changed the way that I teach... I wouldn’t be able to function”; “if I’m not using it, I am missing a connection to make with them (students)”; “it gets kind of engrained in you somewhere along the lines... it has changed a whole of lot the way I teach”; “I try to use what I can but if something disappears ...I have to go find something else (another technology) to do what I want”; and “I know it can work so that is good when you have a bit of confidence behind you going, ‘okay I can do this’”. Within the phrases can be heard a future orientation: these teachers will continually seek out and adopt new tools to aid them in their work.

Shift in teaching orientation.

All participants described natural and strategic shifts in their teaching orientation and classroom instruction style because of technology integration. These seem to loosely fall into categories related to timing: (a) Prep work: more up front time investment, integration and the in vivo learning curve; (b) Classwork: improved classroom communication and dynamics, teacher centered vs student centered, give up control and become more flexible, student assistance; and (c) Post work: assessment measures changes, boundaries.

a) Prep work: All participants described utilizing their prep time in terms of lesson preparation and learning the technology; both were shifts in teaching orientation. These strategies took lots of prep time so that lessons can be run smoothly in classroom. Prep time included transferring tapes to digital format, narrating videos for classes, developing lessons, testing simulations, posting lessons on line, getting familiarized with new technology platforms, etc. These processes took days, months, and sometimes years and often on the teacher's personal time. Many participants described the issue of time management in terms of an upfront investment of time for the practical issues of subject management; others focused on it as a long-term time-saving strategy; others focused on the emotional benefits of being prepared, knowing the material and having a backup plan. While many participants actively researched technology strategies, one participant described his style as a more 'passer-by style of learning', spending little time to actually do any additional research, but observing someone else doing something and then attempting it. One participant has reduced his effort over time as a reaction to dependence on technology and also a realization that technologies are changing all the time.

Each participant spoke about the forethought and attention they gave to integrating technology into the classroom. They described their efforts made on behalf of their students both in terms of ensuring technology was available in the classroom for everyone, as well as developing strategies for students' assignment with increase difficulties and skill levels as they use technology. Some saw the classroom and their place within it as having an 'in vivo learning curve': adopting an 'if you can't beat them, then join them' philosophy. For instance, rather than resist cellphones in the classroom, get kids to use their (cell) technology as functional planners and other useful apps in their phones.

b) Class Work: Classroom communication and dynamics shifted when using technology. Some felt that technology facilitated classroom communication, while in other ways it can distracted attention. Many participants used words such as patience, problem solving, and respect.

Interestingly, one participant viewed technology as the teacher of sorts, educating both teacher and students about patience, problem solving, and camaraderie. All felt that technology had or could aid in building a rapport with the students and a sense of adventure.

Many participants tended to feel that technology had flattened the hierarchy within the classroom. They used phrases such as "a modified direct-teaching role", "facilitator of discussions", "differentiated learning", and "a tour guide of science". This was discussed in various ways: (a) some felt there was a shift from teacher-centered to student-centered learning with students driving their own learning rather than the traditional didactic methods of teacher lecturing; (b) teachers described giving up control and developing a more flexible approach to

teaching. They felt that technology promoted patience to a degree and noted an increased respect, adaptability, and adeptness in decision-making. One participant noted that the shift wasn't so much a change in comfort with the technology, as a change in comfort in the classroom in general, how lessons were designed, and learning from the students; (c) teachers described a shift in the way they view students: using students as assistants (digitalizing notes), utilizing student tech (glitch) expertise and, at times, viewing students as teachers of technology and its applications or of lesson content and information that the student had discovered and shared.

c) Post Work: Each participant described modifications in their assessments and evaluations in three ways: (a) student assignments were often completed on line (labs or summatives); (b) use of technological devices during exams - such as clickers (which also aid in grading); and (c) ability to view and grade student assignments online, whether at school or remotely at home.

An interesting twist to post-work work was the dilemma of boundaries. All participants spoke about work seeping into personal life due to the ease of connectivity. This was true of developing lesson plans and grading, school-related professional issues, and also after-school on-line contact with students. Many admit to be making a concerted effort to keep a work/life balance and to place limits on student contact.

Classroom management and teaching strategy changes.

Managing a classroom is a complex dance for any teacher, with students having different needs, learning styles, interests, aptitudes, attention spans etc. Managing a classroom using technology utilized a shifting skill set according to participants. While most felt that their use of technology changed the way they managed their classes and students, one felt that their

management style remained chiefly unaltered; or better said, he reflected that his style had changed over time but he could not discern whether his style was directly altered *because* of technology. All agreed that use of technology within the classroom offered the student a novelty factor which can grab their attention for longer. All participants believed that benefits to student and teacher included:

- students' ability to grasp complex concepts through visual stimulation
- notes delivered on-line so students were freed up to concentrate on lesson
- utilizing student's devices (cellphones, iPads etc.) to create novel enthusiasm for researching answers
- reduction in teacher writing and explanation because students saw or experienced lesson experientially through technology
- online tests, assignments and pop quizzes
- simulations and computer lab time
- integrating applets and using the Internet as demonstration tools.

Some felt that technology puts the emphasis back onto the actual hands-on, inquiry-based science - problem solving, thinking it through, project-based learning and digital citizenship - meaning that students were responsible for their learning and were expected to use technology to aid them. Many participants also described hindrances to classroom management issues that coincided with technology including on-task or off-task dilemmas, boredom when technology was not available for task practice, and cell phone disruption. It was noted that for some students, technology was another convenient disruption but if it was not technology it would be something else. Oliver described it as "more of a student issue than a technology issue". While one

participant used technology almost exclusively in his class lessons, many described managing their classroom through a series of transitions from technology to blackboard, to didactic lectures, to group work. Two participants focused on the need to reserve lab time and this presenting practical challenges in terms of blocking off a series of times so students could compete longer projects in the lab. On the positive side, students had opportunity to utilize lab multiple times, and in this way available lab technology enhanced student learning.

All participants enjoyed technology for its hands-on approach to learning. Each participant often framed its use as ‘learning together’ and felt that technology changed the way that they explain things.

Practical management of in-classroom technology glitches.

Each participant described issues with the management of classroom technology glitches. We all know that technology can be fickle and when using it within the classroom in front of rambunctious or potentially bored teenagers, it is important to ensure its greatest possible success. Strategies described included “prep and double prep”; this means test your equipment ahead of time and then test it again; adopting a flexible and adaptable lesson plan (and demeanor); resiliency and persistency; reliance on one’s ingenuity; needing to fix one’s own tech problems (or utilizing their students); using one’s own personal devices (for their familiarity and reliability); sharing of ideas with those who show interest; bringing in outside experts or mentors; using hotlines; trading classrooms; and lastly, turning technology off and reverting to tried and true traditional methods of teaching.

All participants also described self-management strategies for frustrations vis-à-vis technology. These shifted based on circumstance and included: skipping or excluding technology; persevering for lesson value; having back-up plans; and developing a reasonable self-learning strategy where the learning curve isn't too steep.

Successful technology applications in the classroom tools.

All participants have incorporated a variety of technologies into their classroom and teaching styles. These are tools which aid them in educating their students and managing their workloads. Tools discussed by participants include: *Applets, Clickers, Chromebooks, E-mail (Yahoo, Hotmail, Gmail), Geometry sketchpad, Google Presenter, Interactive Simulations and Labs (PhEt, Gizmos, explorelearning.com), Internet, ManageBac, PowerPoint, Programs (Google Doc, Markbook, EBGrade, Schoology), Smartboard, Socrative.com, Storyboards, Videos (including VHS and DVD and Internet videos such as YouTube, etc.).*

There are computer labs available in most schools within this school board. These could be booked for classes so that students were learning at the same time. This was particularly useful if students did not have access to a computer at home. As a point of note, participants were familiar with and sometimes required to work within specific frameworks of student needs. IEPs are Individual Education Plans that are designed specifically for students who require extra time, focus, direction, etc. in the classroom. IEPs that require verbatim scribing use a computer, tablet, Chromebook which have an option for voice transcribing programs or applications. These were helpful to students who required assistance in that area and they also assisted students who have writing challenges.

Each study participants described their genuine interest in the ever-changing sea of technological advances and their proclivity for staying current. They had a fluency in describing the tools and their applications as a central part of their teaching strategies. Readers interested in the specific details of the tools currently utilized by study participants and commentary about participant choice of or experience with their tools are directed to Appendix E.

Participant-observer strategies.

Teachers are keen participant-observers. Each participant in this study all described shifts over time in how they perceived themselves vis-à-vis technology. They also described shifts in their students and how such observations helped them, the teachers, to tailor their teaching strategies.

When speaking about integrating technology, all study participants self-reflected on various professional tenets that they live by, including professional responsibility to stay current; continuous learning; using technology in a disciplined way; active engagement in learning technology; overcoming anxiety and resistance; increasing self-knowledge and strengths; taking time to reflect on lesson effectiveness; seeing students as central; using student's language; and time management-boundaries.

A well-trained teacher is skilled at planning, developing, implementing, and assessing lessons over time. All participants discussed issues related to awareness of goal, evaluation of efficiency and effectiveness, as well as utilization of parental feedback. They discussed how technology impacted and shifted their roles within the classroom. While one considered technology as a demonstration aid with the teacher as central, another saw the teacher as more of

a passive facilitator with the computer as central. Still another saw the students as central and the engine to their own learning, and another considered student and teacher as collaborators, each learning from the other. In general, teaching strategies shifted in terms of focus: less one-to-one teaching, more group learning.

A teacher's ultimate responsibility is to the student and so all strategies have the student's best interest in mind. Teachers are always evaluating their effectiveness in real-time within their classrooms. Any strategy includes feedback and, when it comes to technology within the classroom, each study participant described assessing student issues such as adaption vs resistance, continued interest in using technology, and non-compliance vs hesitation. A key to success was use of appropriate technology for target students. There were three general areas that all participants described in assessing effectiveness of incorporating technology: (a) student attitude shifts, (b) soft skill improvement, and (c) lesson content.

- a) Student Attitude Shifts: Many participants said that if technology is being incorporated successfully, students adapt and this appears behaviorally in signs of less apprehension, increased engagement or the WOW factor, and increased motivation, as well as dynamic changes in collaboration.
- b) Participants observed soft-skill improvements such as increased multitasking/playfulness, increased awareness of technology applications, and increased creative problem solving.
- c) Lesson Content: Lesson understanding is essential for evaluating effectiveness and developing further strategies. Assessment of lesson content and knowledge can be gleaned from test evaluations and assignments; additional assessment focuses on skill

development including use of computers, applications, programs, Internet savvy, and technical problem-solving. While the latter is not necessarily part of curriculum assessment, for these participants, the evaluation of technological skills is essential in developing and improving strategies and assessing their own teacher effectiveness. It goes without saying that these teachers believe that technological skill enhancement will usher students into their future.

III. Specific supports perceived as necessary for the incorporation of technology.

There are many factors that can influence how a teacher accepts and integrates technology into their teaching and learning environments. One participant spoke openly about being a “person first and recognizing that the ability to teach to students was preceded by their own learning process.”

All participants discussed many different forms of support. The themes fell into categories which address: I. School Board Support; II. Resource Support; III. Equipment; and IV. Parents. I want to note that support is most often a top-down process, though it is also experienced laterally (colleague to colleague) and sometimes bottom-up (student to teacher). While the immense implication that policies have at Provincial levels of government as they filter down to school board policies was recognized, the focus of participants was mostly at the school board level.

In speaking with the participants of this study, it became evident that there was a need for more support not only from the school board level but also from the Ministry of Education in the form of time, funding, resources, and support.

School board support.

All participants described various ways that school boards could offer support. In terms of general categorizations, these included: (a) Funding; (b) Policy changes; (c) Educational opportunities; and (d) Communication protocols.

(a) Funding for technology centered on (a) how available funding is used, (b) lack of sufficient funding, and (c) choice of who decides how the funding is spent. Two participants spoke passionately about their frustrations with the school board dictating how money is allocated for technologies is spent in terms of restrictions on brands. Both felt that when teachers advocate for new technologies, the board should be prepared to listen and respond to strong arguments if demand for the technology was high or the justification was strong enough.

(b) Policy changes at the school board level were raised as potential areas of support. These included: (a) privacy issues regarding cell phone usage for students, (b) formal contracts issuing permission to do school work from home, and (c) relief time. One participant recognized his limitations in not being privy to looking at student's cell phones but, for the sake of focusing student attention, wished to control which sites students were going to and have knowledge of whether students were on the school board network during his class time. Another participant noted that there may be an unwritten protocol that says 'we teachers have access to our school work even at home' but it would be important to set up policies or contracts legitimizing this. Many participants advocated for policy changes related to relief time for technology-focused activities, including: (a) educational events related to technology, (b) technology-focused class preparation, and (c) making presentations to the school board to advocate for technology. One

participant noted that this was true for other issues as well, saying that teachers give up at the stage of needing to spend excessive personal time preparing to deliver a formal presentation to the school board to advocate for change. He noted that some teachers move into a position at the board where they can advocate formally but then they are making decisions for what they want to do and neglect to ask the teachers what teachers want.

(c) Educational opportunities were a main focus of support for all participants in this study and included (a) Professional development (PD) sessions and (b) Tutorial workshops,

Professional Development – Professional Development (PD) sessions are very important and it is recognized that the school board does provide PD sessions with a technological focus. Many participants took PD sessions on website building, use of certain cameras and programs, and how to input data into computers programs such as Excel. Each participant spoke about their need to be self-directed in the absence of school board-directed training. The main limitations seem to be:

- infrequency – leading to loss of momentum and mastery
- insufficiency – basic level only; need for more advanced levels
- lack of breadth – PD sessions for some technologies or applications but not others
- PD lessons providing an overview but lacking (hand-over-hand) specificity
- gaps between PD lessons and direct (in-school) application - for instance, a PD lesson taught to use a particular software at the school level, but a gap between the lesson and how to apply the technology specifically at the school or department level.

These limitations have lead to different usages between schools. In others words, the software was used but without cohesive application across schools or departments.

Tutorial Workshops are mini training sessions which could be offered to teachers within their schools. One participant wondered whether these kinds of initiatives should depend on teacher demand school by school or whether the school board could provide training across the school district.

(d) Communication protocols were suggested by many participants, including technology news reports, bulletins advising of technology workshops, and how to manuals describing how to implement technology with the pedagogy of each classroom. The school board sends out a Tech News report and this is either sporadic or weekly, as ironically noted by one participant who admits to not reading it. Clear communication and infrastructures that can be accessed from *any* operating system may also go a long way to alleviating the financial strain on the school board.

While researching school board policies and procedures, I came across a number of documents designed to train teachers how to use the new Google operating systems, as well as the newsletter mentioned above. The information provided was useful for new teachers or those who are at the initial phases of incorporating technology into their classroom teaching, but if a teacher has to search out more advanced materials and resources, then perhaps this is an area where improvement should be made. After a search on the school board site, it was apparent that they have no current courses or workshops offered or, alternatively, that course lists are too deeply embedded within the website, making them too difficult to find.

One participant noted the fine balance between encouraging teachers, pushing teachers to try new things, and respecting that it takes time to learn and become comfortable with new endeavors. Everyone has different comfort levels. Like for their students, it is a complex dance between dependence and autonomy. Each participant illustrated a need for exposure to new things but also need (a) the right to decide if it was going to work in their particular classroom and how they wanted to implement it, and (b) time to become comfortable with it.

One participant noted that it was hard to know what technologies will evolve and how to help students prepare for their future. It's just hard to imagine what may be coming in the next decade: websites disappear, applications and innovations materialize almost daily. It may be hard to stay abreast of technology. While she had no answer for how to manage this, she believed that creative ways to inform teachers about technology innovations without simultaneously creating overwhelm and burnout should be paramount.

Resource support.

Given that all school life and activities flow from the directives of the school board, resource support, in a strict sense, falls under the school board's rubric. I have separated it out as its own specialized form of day-to-day support. As discussed by participants, Resource Support includes (a) Tech-PLC, (b) Technicians, (c) Specialized instructional coaches, (d) Consultants, (e) Spontaneous peer support, and (f) Outside expertise.

Technology Professional Learning Communities (Tech -PLC) was an initiative developed to create a milieu of learning whereby teachers could learn from "experts" within the school or school board. There are many people with differing skills set at any institution and a teacher or

school board personnel that has highly developed technological skills, such as website development, program knowledge, etc. can be utilized to instruct other teachers within the school. One participant noted that this model of support was very useful, but these Tech-PLCs were left to develop their skills on their own time and it would be, in his opinion, good if the school board outwardly supported them through funding and relief time.

Technicians were IT professionals and they provided technical support for the day-to-day functioning of technological equipment. Because of their knowledge base, they were also utilized for problem-solving programming glitches or other technology related software issues. They were in high demand and were sometimes not available. At other times they were not technically skilled enough for more advanced kinds of tech issues. There used to be a technician in each school but this had been reduced to one or two technicians for the entire secondary level. Teachers ideally needed a designated technician at each school who had experience troubleshooting the technology in the school so that teachers could feel comfortable “playing around with” technology and have assurance that a technician was available if they got into trouble. All participants agreed that added support here would be helpful.

Specialized Instructional Coaches were used for a short period of time as a proactive way the school board attempted to support the needs of teachers. Specialized instructional coaches were teachers who had board-funded specialized training. In connection with the Tech-PLCs, these coaches shared their training as well as specific pedagogical knowledge. Teachers found them useful and suggested that specialized instructional coaches become re-established and more subject-specific, such as a ‘math-tech instructional coach’ or a ‘science-tech’ coach. It

was also suggested that technology-focused professional development should be shared amongst a few people within each department so it's not always the same person doing it all the time.

Consultant: One participant noted that some years ago the school board hired a science teacher consultant whose job was to share science ideas with other members of the board and to facilitate physics teacher meetings to share ideas for an hour (4-5 pm) once a month. This was very useful and it was particularly pleasing that it was a school board-organized initiative. The board doesn't hire consultants anymore and it was noted that this initiative was a useful form of support.

Teacher-to-teacher peer support happened spontaneously within all schools. Peer mentorship was seen as a way of making the training applicable and transferrable for teachers. Mentoring teachers and providing them with the skills to adapt technology to their curriculum and teaching styles via learning from colleagues could help to strengthen the longevity and perseverance when barriers arrive. Helping teachers connect to one another and providing space and time for active learning was useful. One participant spoke of making use of the experts in his school but said it can become exhausting and time-consuming for those teachers. There are talented teachers within the board who have made the switch to technology. Utilizing these teachers to help others learn and become comfortable with technology was something that should keep happening for more people to starting using technology.

One participant noted the frustration of having defunct technology and not enough school board expertise to resolve problems in a timely way. *Outside expertise* (Geek people, PC/Mac experts etc., online help-line services) should or could be more readily accessible so that lessons do not get disrupted and things stay on track.

Equipment.

It was surprising to me that technology equipment was only mentioned briefly during discussions of support; perhaps because it is obvious. One participant noted that classrooms designed with technology are specially designated within schools at present; most classrooms are ‘basic’ without technology. As an ideal, all classrooms within every school would be technology-enhanced. Another participant felt it would be nice to have a variety and diversity of technology devices available, including cell phones, and that these technologies would be updated regularly (as opposed to being 10-15 years old). One participant felt that in a perfect world, every classroom would be well-equipped and every teacher would be using the technology.

Parents.

Parents’ collaboration was a bonus to any teacher and participants mentioned this as a unique form of support. Technology has the potential of enhancing that support with programs like ManageBac, an online calendar, messaging, and management tool whereby parents can see what assignments were coming up and parent –teacher correspondence could take place to ensure students stay on track in their learning.

Chapter 8: Discussion

Integrating Findings with Current Research

The marvels of coloured television that captivated society in the early twentieth century was lost on the next generation, just as the wonders of mobile technology and the Internet has been lost on today's students because they have been brought up in a society where technology is simply commonplace. Today's students (and adults) are surrounded by new technologies in many aspects of their lives such as taking the bus to school, listening to the morning announcements, purchasing snacks from the vending machines, interacting with the family's smart television, and interacting with computers, gaming systems, and mobile devices. Due to this exposure and students' natural inclination towards new technology, it is important to understand the beliefs and views of educators about their experiences, acceptance, and intentions when integrating technologies into their teaching and learning practices.

It has been said that many of the jobs of tomorrow have not been created yet. This is a powerful statement and one that is full of promise as well as potential anxiety. I had presumed that teachers, especially science, mathematics, and technology teachers, were under considerable pressure to prepare students for the jobs of tomorrow due to technology saturation into our society. This intuition was accurate insofar as all participants expressed feeling certain pressures; surprisingly however, participants *did not* speak specifically about their perceptions of technology with respect to teaching *science*. In other words, their perceptions seem to be focused on experiences of teaching generally rather than teaching science specifically. Because I did not interview teachers from other disciplines, I cannot explicitly state all teachers share these same

experiences with science teachers. Because these science teachers did not focus their discussions on science, I can therefore state that the common experiences shared herein belong first and foremost to a small group of teachers (as opposed to science teachers) integrating technology into their classrooms. Their status as science teachers, seems to have been a peripheral factor in the study. The fact that they were teachers was the primary factor.

This thesis investigates the perceptions of experienced classroom teachers' acceptance and usage of technology and sheds light on the possible factors influencing how teachers interact, use, and ultimately accept technology into their teaching practices. In this section, I set my thesis within the existing field of research to explore how it corroborates, refutes, or extends our understanding. I have categorized this section into the same framework as the Findings section: introduction, limits and constraints, teaching strategies, and necessary supports. The purpose of this thesis is not to get an illustration of the average teacher but to showcase the diversification of the various issues shared by participants. The purpose of the thematic is to expose the various comments of the various issues made by some or all of the participants and compare these results actively with current research in the field.

Limits and constraints.

Information and communication technologies have grown increasingly universal, powerful, and adaptable (Levin & Wadmany, 2008). Yet, as showcased in the previous chapter, technology is not always a reliable tool and when it is, efforts to integrate it bump up against a variety of mitigating factors. The following section of this discussion will emphasize the frustrations that are common amongst other educational research findings. When it comes to the leading factors that hinder the use of technology, questionnaire participants confirmed the qualitative themes of

time (85%), lack of training (70%), lack of support (35%) and availability of devices (25%). Although these results can not be generalized due to the sample size, they are important to mention because they provide a glimpse into the working environment of the interviewed participants and give support to the evidence of their narratives.

As teachers attempt to integrate technology into the classroom, they experience limits and constraints. Previous research by Li (2007), Pelgrum (2001) and Demetriadis et al. (2002) cite obstacles that teachers perceive as major impediments to be: (a) the conditions of materials: insufficient number of computers and insufficient technology expertise among teachers; (b) difficulty integrating technology into the regular curriculum and instruction; and (c) a lack of supervisory and technical staff.

These themes appeared within this research but, interestingly, were more fully expressed when participants were asked about the kinds of support needed to integrate technology successfully. When considering limitations or constraints in implementing technology, a nuanced set of themes emerged in this thesis including: I. Technology limits: glitches; II. Teacher: personal and professional limits; III. Student limits; and IV. Practical limits. The specificity of these themes extends the discussion within this research area.

All participants in this study spoke about specific limitations of the technology itself and these were subcategorized into (a) hardware issues related to the tools within the schools; (b) hardware and software issues related to the greater school board infrastructure that gets information to the tools; and (c) external technological glitches that affect information delivery to greater society (including school boards) such as brownouts, and Internet provider shutdowns.

Perceived limitations described by participants fit with the common explanations from current literature. All participants in this thesis have accepted and integrated technology into their classrooms, and yet consider themselves to have personal and professional limitations. Supporting this evidence, Ertmer (2012) also found a strong link between how technology is used and teachers' own perceptions of the relevance of technology. Participants in their study indicated that the "strongest barriers preventing other teachers from using technology were their existing attitudes and beliefs toward technology, as well as their current levels of knowledge and skills" (pg. 423). In agreement, Li (2007) found that techno-phobia is not necessarily caused by a lack of exposure to technology. Again, this is evident from the narratives of all the participants noting that many colleagues have exposure to technology but may be reticent to use it. Calling on earlier evidence, Mentz and Mentz (2003) had similar findings: they noted that teachers and educators are expected to equip learners with the basic technology skills required by society, yet many feel inadequately prepared to do so. Presently, with the saturation of technology in our society, although many participants were proficient in technology in and outside of the classroom, it is fair to speculate, based on their discussions that comfort outside the classroom does not necessarily translate into comfort within the classroom.

Another supporting study by Wang, Hsu, Campbell, Coster and Longhurst (2014) showed that teachers may know how to use certain technology to solve personal or work-related issues, but they report less frequency in having students use these tools compared with their own use. As the literatures shows, there is a diversity of limitations experienced by teachers across curriculums. The limitations experienced by all participants of this thesis, have been categories into three themes: (a) practical self-constraints: lack of time, lack of knowledge, technically unsavvy (can't fix minor problems), limits related to spending personal money due because of

lack of resources, software upgrading pressures; (b) self-experience constraints: anxiety and giving up prematurely, self-reliance, and isolation; and (c) other: lack of collegial support and knowledge, multiuser computers where other teachers change settings, multitudes of platforms. Categorization of participants' personal and professional limits into themes of practicality, self-experience, and other external constraints on personal effectiveness provides a beginning framework by which to study the broader teacher population through future research studies.

I found only one study in my review of the literature which specifically addressed student limits in adopting technology, and it spoke more to student adaptability than limitations. Research by Wang (2014) found that many students in their study were not familiar with ICTs (or web 2.0 tools), but once teachers introduced students to a new technology to support learning, students could quickly learn how to see it and they were eager to use more technology. As learned from their narratives, each of the participants spent time talking about their attempts to integrate technology and the responses to their efforts by their students. By and large, students enjoyed and benefited from working with technology but at time there were difficulties. These included student resistance and difficulties with adoption, students getting bored, students using their own devices (so a lack of classroom cohesiveness), students being at different levels of technological expertise or interest, complications with dynamic changes in the classroom with teachers need for collaboration, and need to use some students as in-classroom tech help or mentors (while other students wait and become disenfranchised). As with many things, aspects of these changes are beneficial for some students and limiting for others and this fact was noted by study participants. Humble-Thaden (2011) had similar findings, concluding that before a school system adopts some technologies (in this instance, cell phones) as learning tools, student perception should be investigated and instructors may wish to consider the use of this type of

technology in the classroom as an option rather than as a requirement (see Appendix F for a review of the research on student perceptions).

Past evidence of the factors affecting a teachers' use of technology in their practices are grouped into the following categories by ChanLin (2006): environmental, personal, social, and curricular issues. These themes touch on some of the practical issues within day-to-day school life that affect technology use by teachers within the classroom. These themes differ slightly from the themes found within this thesis, but they overlap. All participants within this thesis deliberated on practical constraints they experience, including issues of a lack of required physical space and support. More specifically they discussed: (a) Classroom space or equipment availability: classroom transiency, limits of physical space, time and equipment, reductions in the number of phone lines for connecting technology systems, limitations on students using personal devices; and (b) Support issues: defunct on-line support communities, too-quick implementation of technology without enough training, technical support limits. These are further elaborated on in the Necessary Supports section.

A pertinent study was conducted by Siorenta and Jimoyiannis (2008) who specifically focused on science teachers, their need for covering physics content in the mandated curriculum, and for preparing their students for examinations. The study examined the educational difficulties teachers faced in applying novel instruction approaches in classroom practice. Difficulties included preparing, organizing, and managing student learning tasks based on laboratory inquiry and in technology learning environments. Three interfering factors preventing teachers from using ICT tools in everyday instructional practice were found: (a) teachers' pedagogical and instructional difficulties, designing students' learning activities and managing

students' work with ICT, (b) teachers' being unconvinced of the potential of ICT enhancement to students' understanding and learning in physics, and (c) computer labs not being free when physics teachers want to use them. These constraints continue to affect technology integration based on the results of this study. While this thesis focused on science teachers' perceptions (as opposed to Siorenta and Jimoyiannis's (2008) behaviorally based study), there are parallels and differences in experience. Many participants of this thesis, did not describe having difficulties in designing lesson plans or being unconvinced of technologies benefits. On the contrary, many participants enthusiastically embraced technology and adapted their teaching styles to support the learning that technology brings. It must be noted that many participants were already techno-converts whereas the Siorenta and Jimoyiannis (2008) study participants were working within a mandated system so some were likely not all techno-converts. Both studies are in agreement that there exists difficulties with availability of computer labs and both studies noted some troubles with managing learning tasks, though all participants of this thesis specifically focused on the typical resistance and boredom issues of students compared to student learning issues.

In conclusion, glitches are, in a way, 'a fact of life' when working with technology. This is true of practical glitches (i.e. "the computer won't turn on") and the broader limits and constraints experienced when teachers attempt to integrate technology into the classroom. Such issues can make it hard for teachers to keep up. This study has expanded on the scope of understanding teachers' perspectives in hopes that the clarity around limitations, glitches, and constraints can provide useful information to both teachers (in understanding what their process of technology adoption may be like) and to school boards and policy makers as an aid in constructively addressing hardware and infrastructure needs.

Strategies.

The question of what strategies are perceived as successful using technology in the classroom brought about some broad and interesting findings, from discussions of motivation and attitudes, to discussions of practical class management, to discussions of technological tools. There are different motivations that drive teachers to adopt technology.

This thesis is primarily focused on issues of teacher perceptions. After a search of the literature on teacher motivations and beliefs, it is evident that this thesis has merit to the field of research. All participants spoke extensively about their perceptions but in very specific terms. Research that focusses on *specific strategies* associated with teaching and integrating technology is sparse within the literature. The themes that emerged through discussion with participants in this thesis therefore add a classification system that may be useful for future research. Various themes of teaching strategies that emerged through the interviews were classified into the following sections: (a) Attitude: technology as shaping teaching attitude, (b) Shifts in teaching orientation, (c) Classroom management and teaching strategies, (d) Practical management strategies of in-classroom glitches, (e) Successful technology applications and tools, and (f) Participant-observer strategies (strategies developed by participants based on observed in-class feedback).

Research by Kiraz (2006), Levin and Wadmany (2008) and Teo (2009) has found that technology integration in schools depends largely on teachers since they are gatekeepers for all kind of innovation introduced to the education systems and in particular the learning and teaching processes in their own classrooms.

Of all of these themes, the theme of teacher attitude was by far the most prevalent in the literature, and even then, studies were weighted toward issues of attitudinal resistance.

So, as backdrop to discussions on successful strategies for use of technology, the topic of teacher resistance should be briefly introduced. It is important to realize that the teaching profession is not duplicable. Every teacher in the classroom has entered the profession with a different teaching style, personality, strengths and weaknesses, and experiences. With this in mind, many governments have intensified their commitment to incorporating technology into education (Pelgrum, 2001) and there is a fine balance between proactive support and perceived attempts to force technology usage onto teachers. Resistance and self-doubt are natural by-products of integration strategies that have gone wrong. For instance, Hooper and Rieber (1999) propose that when a teacher experiences early satisfaction based on their limited use of technology, they are more likely to reject further technology implementations at the first experienced glitch. When integrating technology, it is important to remember that too many perceived limitations or glitches will blur the line between usefulness and frustration such that teachers may continue to shy away from total technology acceptance in their classrooms.

According to Teo (2009), teachers tend to possess greater autonomy over their choice of technologies than general technology users. This is evident from the narratives. Many participants of this thesis shared their experiences of choosing which simulation to use, online communication tool and even to what degree they integrate with technology. There is a link between these findings and other research. In Lee and Lee (2010), they found that many teachers may not use technology if they do not value it in their teaching. This statement has weight, especially because teaching has a diversity of teaching styles and approaches. This is clear even within this thesis, with one participant not seeing the value in making his lessons available online

to his students to another participant who provides everything. As well, Bull, Bell, and Kajder (2003) proposed that teachers often do not feel adequately prepared to implement and evaluate teaching and learning strategies in regards to their pedagogical requirements while using information and communication technologies. These feelings of inadequate training and preparation coupled with Martinovic's (2011) question of whether or not a teacher with less stamina could sustain challenges and persist enough to overcome the difficulties experienced when integrating technology into the classroom were echoed by all participants. A teacher's level of confidence and competence in using technology can be a limiting factor for integration. Many participants speculated to some extent about the reticence of their colleagues to incorporate technology into their classrooms. Mostly they cited issues of training, personality style, time, support, and confidence. No one in this study imagined that colleagues viewed technology as not being viewed as valuable or relevant. On the contrary, the sense was that everyone, participants, colleagues, and policy-makers alike, saw technology as inevitable and important.

Attitude.

In contrast, participants' beliefs and perceptions, as well as their lived experiences, can *fuel* their ability to adapt to changes; this has been illustrated in the narrative sections of this study. Participants agreed that the ability to overcome the internal struggle of control when faced with a challenging or unexpected situation with technology is an important skill to have. Research by Teo et al. (2008) also found that the success of any initiatives to implement technology in an educational program depends strongly upon the support and attitudes of the teachers involved. And so it begs the question of how to develop a positive attitude or what makes a positive

attitude and what shifts resistance. Li (2007) did research that found that an individual's mindset, perception, attitude, beliefs, and even confidence separate them from their peers. All participants in this thesis spoke of ways that they are different from the teachers who aren't integrating technology and how technology has shaped them in the *ahead of the curve* section of their participant narrative. They discussed issues of attitude, including attitudinal tenacity, problem-solving mentality, technology as a preference, active decisions to change their teaching style, embracing change, and recognition of the long-term time benefits of technology, embracing remote connection, and having passion. These internal factors play key roles in shaping the teachers' practices.

Research conducted by Kotrlik and Redmann (2005) found that, despite feelings of anxiety, when it came to technology integration, teachers in their study perceived that they were effective at using technology. This thesis draws a similar conclusion. All participants discussed the struggles but also the great satisfaction they get when lessons go well, technology works well, and they feel themselves as effective. A study by Soloway (2000) proposes that competency in the use of technology develops when tools can be called upon as they become relevant. A working definition of integration from the literature is when a conscious decision is made to designate a certain task and responsibility to technology (Hooper & Rieber, 1999; Kenton, 2005; Martinovic, 2011). Many participants in this thesis are on the leading edge of technology and spoke readily about their skills being pushed to develop as evolving technology demands it. Technology leads and our skill development follows. All participants spoke about confidence and having, or building, what I call attitudinal tenacity. There are various studies that support this finding. Yuen and Ma's study (2008) emphasizes the importance of building up a teacher's confidence in using technology and thereby increasing their willingness to use other tools such as

e-learning technology in the future. In accordance with this observation, Ertmer and Ottenbriet-Leftwich (2010) suggest steps for building a teacher's confidence: 1) allow teachers to play with the technology, 2) start small with integration, 3) collaborate with peers, and 4) participate in professional development that incorporates technology. Similar thoughts were expressed in this thesis. All participants advised teachers who are novice users of technology to develop an attitude of playing around with technology, together with openness, flexibility, and trust in regards to changes, as well as an understanding that confidence comes with experience. Similarly, they suggested steps such as 'just do it' and 'one step at a time'. This finding corroborates earlier research by Lam (2000) and Sugar (2004), who found that technology usage increases as the teacher becomes more confident.

Shifts in teaching orientation and philosophy.

Each participant described natural and strategic shifts in their teaching orientation and classroom instruction style because of technology integration. In other words, they did their teaching differently (their prep work, classwork, and post work) because of their use of technology. Because discussions seemed to fall into areas of lesson timing, they were categorized that way.

As a backdrop, Kim, C., Kim, M., Lee, Spector, and DeMeester (2013) found that teachers' beliefs about the nature of knowledge and learning, and their beliefs about effective ways of teaching were related to their technology integration practices by providing new technologies, professional development workshops, and technical and pedagogical assistance. This thesis corroborates these findings. All participants embody their beliefs: they participate in technology

workshops, help colleagues with technology problems, promote their technology ideologies, self-teach technology skills, etc. Siorenta and Jimoyiannis' (2008) study focusing on physics instruction found that teachers could be grouped together in terms of their beliefs and usages of technology. They grouped teachers into three groups, (a) teachers who have traditional beliefs about how students understand and learn physics, (b) teachers who have non-traditional beliefs of how students understand and learn physics, and (c) teachers with non-traditional beliefs about physics understanding and learning while they perceive the role of textbook learning to be of great importance (pg. 194). While study participants in this thesis were not all physics teachers, using this classification system, all participants would fall under categories (b) and (c). Chikasanda, Otrell-Cass, Williams and Jones (2013) showed that teachers have enhanced knowledge of technology and technology education. However, their classroom practices showed technological pedagogical techniques that reflected their traditional strategies for teaching technical subjects. Many participants in this thesis had a range of traditional to non-traditional teaching techniques, mostly incorporating mixed-method approaches of didactic and student-centered learning, and traditional teaching strategies and tech-focused strategies.

As corroborated by this research, Gorder (2008) reported that teachers who use technology regularly in their personal lives are more likely to integrate instructional technology activities into the classroom to meet the needs to their students.

(a) Prep work: All participants described more up-front time investment to integrate technology into their classroom. Integration included teachers needing to learn about the technology themselves as well as time to prepare lessons which used technology as a tool. They described an in vivo learning curve as integration took place. These findings corroborate research

by Cochrane (2008) who showed that teachers require significant time to become comfortable with using mobile web 2.0 tools (simulations, clickers, cell phones, etc.). As well, Cochrane (2008) concluded that creating a successful learning environment using technology requires teachers to plan carefully and to have an appropriate pedagogical design and access to technical support. Furthermore, Cochrane (2008) found that the outcomes in student engagement, increased motivation and productivity, and the development of a technology-pedagogical toolkit is correlated to the time investment from the teacher (pg. 184). As well, research by ChanLin (2006) found that strategies that foster creativity require more time and collaborative effort for planning and implementing.

(b) Classwork: Many participants seemed to portray a flattening of the traditional classroom hierarchy within day-to-day functioning of the classwork. They described improvements in classroom communication and dynamics, shifts in their teaching practices from teacher-centered to more student-centered, increases in their flexibility and willingness to give up control, a building of rapport with students, and openness and need (at times) of student assistance. These findings corroborate previous research: Cochrane's (2008) study above seems to highlight the dynamic shifts within the classrooms of tech-savvy teachers. Research by Webb and Cox (2004) and Siorrenta and Jimoyiannis (2008) discuss classroom evolution from a focus of teacher-centered instruction to student-centered learning environments, noting that the integration of technology in science education is associated with these fundamental changes (as opposed simply to improvement of traditional methods of instruction). While many participants spoke readily about their shift of in-class dynamics vis-à-vis the use of students as technology assistants, I could not find previous research which points to this shift in dynamics.

All participants of this thesis confirmed the importance of relationship-building and making judgment calls in real-time. They focused on adaptability and flexibility in the moment. They spent time talking about the dilemmas of cell phone use, and these findings are similar to Charles' (2012) who spotlights shifting classwork dynamics as it relates to cellphone use. His study focused on the delicate balance of rule, discipline, and compromise of using cell phones in the classroom, stressed that there needs to be give-and-take or "a judgment call" around the rules for the new networking tools, as well as reiterated the value of the building of rapport and relationships to the task of establishing workable protocols within classrooms. Charles also stressed that "rules are only as good as their enforcement, but the enforcement hinges primarily on relational trust" (pg. 11).

All thesis participants described a closer engagement with their students through the introduction of technology in their teaching practice. Rau et al. (2008) suggested that mobile communication technology can help bond the instructor and student without increasing student pressure. Implications of their research suggest that technology helps instructors who are wanting to shorten instructor-student distance and encourages more communication between the two sides.

Many participants described such flexibility that at times the students become the teachers, by bringing to the teacher's awareness Internet information or technology skills that are beyond curriculum or the teacher's knowledge. Far from being intimidated, all participants embraced this two-way learning as optimal. Bull (2003) also describe this phenomenon, saying that in some cases, technology makes it possible to go beyond the existing curriculum and address content that would not otherwise be accessible. More specifically, Bull's study illustrated how "graphing

calculators can be used to explore and integrate multiple representations of numerical, graphical, and algebraic data on a single, handheld computational device” (pg. 66).

All participants in this thesis have moved away from using computers solely for drill and practice tasks to using technology as an instructional tool to enhance student learning. It is interesting to note however that one participant actively engages students by using their mobile phones to answer questions in class, a tool and privilege that is not widely used as a teaching strategy. This kind of recognition of technology’s potential and creative use of technology with classroom students bodes well for student learning. Other studies, ChinLin (2006) as well as Thomas and Orthober (2011), found that technology can benefit instruction because it engages and motivates students while providing unique instructional opportunities.

(c) Post work: All participants described technology as shifting the way they evaluate and assess their students. This includes (a) student assignments that are often completed on line (labs or summatives), (b) use of technological devices during exams – such as clickers (which also aid in grading), and (c) ability to view and grade student assignments online, whether at school or remotely at home. This finding is in contrast to research by Bulter (2000) who observed that many feel discomfort when trying to find a way of evaluating using Internet-based resources. Bulter’s study discovered that many administrators and teacher colleagues did not feel capable or comfortable evaluating the contribution made by an interactive laboratory exercise or an online course. Bulter suggested that the sophistication of assessment process needs to increase to be able to measure the degree to which Internet-based resources have a positive or negative correlation with learning. Although many participants in this thesis did not comment on evaluation difficulties, they did make reference to evaluation improvements by way of

technologies; these improvements had to do with ease of use in accessing and assessing assignments vis-à-vis technology and also increase in student learning vis-à-vis technology. This finding verifies Bulter's (2000) concluding postulation that a missing link is the evaluation of the value *added* by the Internet. Andrews et al. (2011) suggested that teachers need to design assessment tasks that evaluate individual knowledge construction, and also the aggregation of knowledge built by many through social media spaces.

Many participants of this thesis also discussed their need to establish post-work boundaries because of ease of online technology. This included boundaries with students' ease accessing them during their personal lives and boundaries with work seeping into their private time. I did not find any studies in the research which specifically addressed teachers' need for boundaries between in-class and home availability while using technology. In a slightly different but equally important note, the Ontario College of Teachers (2011) states that:

Respecting professional boundaries online is key to maintaining the public trust and appropriate professional relationships with students.... If you're going to create and maintain an online presence, make sure it aligns with your professional reputation.... A good benchmark to follow is to share with students only the information that you would comfortably share in a classroom setting or in the community.

Classroom management and instructions design change.

Bull (2003) predicted a watershed event for technology in the schools. This 13-year-old study predicted that a major turning point in education would occur when each student has a

personal portable computing device. They also predicted that when this happens there would be two possible paths: (a) efficiencies would be achieved through electronic distribution of curriculum materials previously disseminated via print; and (b) teachers and students would assume ownership of materials, modifying and adapting them to address individual learning needs. Fast forward to 2014/2016 and both of these predictions are evident in discussions with thesis participants.

Managing a classroom using technology utilizes a shifting skill set according to all participants. Use of technology within the classroom offers the student a novelty factor which can grab their attention for longer. All participants believe that benefits to student and teacher include: (a) students' ability to grasp complex concepts through visual stimulation; (b) notes delivered online so students are freed up to concentrate on lessons; (c) utilizing students' devices (cellphones, iPads etc.) to create novel enthusiasm for researching answers; (d) reduction in teacher writing and explanation because students see and experience lessons experientially through technology; (e) online tests, assignments, and pop quizzes; (f) simulations and computer lab time; and (g) integrating applets and using the Internet as demonstration tools. These are innovations that all participants have developed themselves or adopted from others. Research by Wang et al. (2014) found that science teachers have been at the forefront of technology transition and, in fact, have ample opportunity to integrate technology to allow students to conduct their work.

Andrews, Tynan and James (2011) noted that teachers need to consider learning activities that draw on how learners wish to connect. Like other strategies and activities, the use of computers should encourage students' curiosity, participation, involvement, and different

approaches to a question or an issue (ChanLin, et al., 2006). As means of support, Kirk and Pitches (2013) noted that technology needs to be introduced gradually, as an integral part of the work rather than an ‘add-on’. In discussions with thesis participants, it is evident that the management of classroom activities is in line with each of these research studies.

Practical management strategies of in-classroom technology glitches.

Technology can be fickle and thesis participants described strategies in the management of classroom technology glitches. Research by Becker (2000) found that technology-experienced teachers have a combination of skills including technical knowledge about computers, experience using computers professionally, and a strong motivation of student computer-use objectives, and employ the necessary software to result in their ideal student engagement. All participants of this thesis extrapolated on these skills during the interview process using anecdotal accounts of glitches and their resolution.

Successful technology applications in the classroom: Tools.

Each participants’ selection of technology tools used in the classroom are on trend and ahead of the trends within the literature. Technology is being used by all thesis participants to enhance student learning, increase teacher efficiency, and develop twenty-first century technology skills. All participants use technology a minimum of five hours a week and utilize a wide range of technology tools from hardware (computers, Smartboards, clickers, mobile devices) to Internet search engines (Yahoo, Hotmail, Google), to applications (ManageBac, PowerPoint), to programs (Google Doc, Markbook, EBGrade, Schoology), to interactive simulations and virtual

labs (PhEt, Gizmos, explorelearning.com), to videos and DVDs and Internet-based videos such as YouTube, to global educational website Socrative.com, to Storyboards and Chromebooks and Applets. The range is wide and varied; in fact, more varied than research by Wang (2014) who found that tools teachers used at least once a week inside of school were word processing, spreadsheets, presentations, text messaging, and web search engines. Likewise, both Becker (2000) and Larson, Miller and Ribble (2010) found that the main technology tools used by many teachers were (a) word processing, (b) multimedia presentation, (c) spreadsheets, and (d) Internet. According to these researchers, these tools were created for improving teachers' efficiency of teaching preparation and used for assessment activities such as grade keeping, attendance charts, and performance assessment checklist.

All participants have incorporated a variety of technologies, as above, into their classroom and teaching styles. These are tools which aid them in educating their students and managing their workloads. This corroborates findings by Hernández-Ramos (2005), who found that technology tools both improve educators' professional productivity and promote student learning. In a study by Beyerbach, Walsh and Vannatta (2001) both pre-service teachers and high school students told researchers that technology allowed them far more choices and direction in their own learning. This seems to be the sentiment of many thesis participants as they reflected on their own use of technology and the autonomous, self-guided learning their students engage in through technology. Techno-tools are seen as useful and effective as teaching aids.

Each participant stressed over and over again that the most important strategy for any teacher wishing to incorporate technology tools into their teaching is to 'just start'; to learn about the tools itself through trial and error. A study by Peart (2002) emphasized, additionally, the

importance of starting from the beginning and understanding the complexities of computer technology first, especially for faculty who are not comfortable or have had no formal training. Further details and recommendation for advanced training will be addressed in the next section, Necessary Supports.

Participant-observer strategies.

The participants in this thesis all described shifts over time in how they perceived themselves vis-à-vis technology. They also describe shifts in their students and how such observations help them, the teachers, to tailor their teaching strategies. As they teach, their strategies change based on verbal and non-verbal feedback from students and their own reflections on self-performance and lesson success. While it is beyond the scope of this thesis to focus on student's perceptions of technology, it is my belief that student perceptions and use of technology is central to teacher understanding and integration of technology. The student-teacher relationship is dynamic and thus, understanding student perceptions helps to tailor teaching strategies. With this in mind, I have included in Appendix F, a review of relevant research on student perceptions of technology.

Teacher-observer strategies, while not overtly described as such, are historic and natural strategies for improving effectiveness. Cochrane (2008) requires that teachers are provided with the flexibility to critique, reflect on, and modify their classroom environments as required. Similarly, Larson (2010) found that teachers need to be able to connect to their students' digital worlds to engage and motivate a new and very different type of learner. This thesis concurs with the finding that speaking the students' language (verbal and technological) allows teachers to

connect with their students in that moment and this, in turn improves student learning. All participants describe assessing their effectiveness of incorporating technology through three modes of feedback: (a) student attitude shifts (b) soft skill improvement (c) lesson content.

Many participants also discuss a self-reflexive stance which helps them gage their effectiveness. There are many studies that look at the benefits of teacher self-reflection as an aid to improved and effective teaching. Most of these studies (Carr and Chambers, 2006; Chikasanda, 2013; Putnam and Borko, 2000; Walsh and Vannatta, 2001) focus on self-reflection in terms of enhancing professional development rather than the self-reflection as an in class strategy and feedback loop between student and teacher; perhaps this is because the dynamic is implicit in any teacher-student dyad. The teaching profession is evolving from a focus of teacher-centered instruction to student-centered learning environments and the integration of technology in science education is associated with these fundamental changes (as opposed simply improvement of traditional methods of instruction) as noted by Sioranta and Jimoyiannis (2008), and Webb and Cox (2004).

It is worth briefly touching on literature focused on self-reflection as an aspect on professionalism and (formal and informal) professional development. Perceptions of technology can change when given time for self-reflection. In support of these findings, Walsh and Vannatta (2001) found that after exposure, training, follow-up mentoring, and self-reflection, pre-service teachers changed their views of technology infusion from preparing and delivering lessons using technology to expanding their vision of activities to be used with technology to support student learning. All thesis participants remarked on their improved views and confidence through exposure and self-reflection. In another study, Carr and Chambers (2006) findings suggest a need

for a cultural change in regards to two aspects (a) a culture of sharing and reflecting on practice (b) a culture of using online communication tools as an integral part of classroom teacher practice need to be developed within schools. In their view schools do not adequately value collegial reflective sharing of practices, and classroom teachers do not use online communications tools as an integral part of their professional practices. Indeed, Putnam and Borko (2000) note that collegial sharing of information and ideas about practice has been found to encourage teacher self-reflection and to support the risk taking needed to transform practice. Similarly, Chikasanda (2013) found that on-going support, reflection and feedback underpinned the professional development processes to enhance teachers' prospects of putting aside old traditions and culture to implement new practices in their classrooms.

These last studies touch on the useful aspects on self-reflection and professional development. It will be obvious to the reader that one of the hallmark strategies for successful use of technology in the classroom is a teacher's responsibility to their professionalism through ongoing training and development initiatives, and there are many research studies focused here. These are reviewed more fully in the section Necessary Support.

Necessary support.

If we are open to it, each and every one of us is on a learning curve throughout life. Providing support is essential to the success of any endeavour and support can come in all shapes, sizes, methods, and opportunities. In the teaching profession, individuals cannot be expected to re-create the wheel or continuously discover new technologies without risking burn out, nor is it possible to duplicate a specific teaching styles en masse. Teaching is personally

nuanced yet fundamentally collaborative by nature and thrives on a foundation of support and continuous learning.

While teachers spend the majority of their time independently (working in front of and beside their students), the effectiveness of their teaching is influenced by the backdrop of support they receive. No one is an island and there are many forms of professional support that enrich successful teaching. Having said this, there seems to be a missing link between the ideals of education and teaching and the realities of life in the classroom. Each participant of this thesis had many accolades for the developed strategies and real conundrums faced by their governing bodies (at Ministry and school board levels) when it comes to integrating technology. At the same time, they had thoughtful advice and an awareness of gaps that may be helpful in bridging the divide between educational goals and teacher effort to incorporate technology.

This divide was noted long ago in research by Voogt and Pelgrum (2005), who described an incompatibility between the goals of education, the interaction between teachers and students, the educational and information resources, and the curriculum goals and materials. With the government's intensified commitment to incorporating technology into education (Pelgrum, 2001), there is much to be said about the kinds of support necessary to align these initiatives with day-to-day teaching practices. From this thesis participant narratives, we know that fifteen years later in 2015/2016, true technology integration has not taken place and active support remains spotty. Research by Bauer and Kenton in 2005 suggested that schools had not achieved true technology integration and, in 2016, it begs the question why.

In part, issues of time, training, and lesson planning were noted by many questionnaire respondents and interviewed participants in this thesis and research studies have noted this as well: technology is often perceived as a burden on teachers' time because it interrupts

instruction, requires additional training, and takes time to plan (Lim & Khine, 2006; Swan & Dixon, 2006; Wachira & Keengwe, 2010). As previously surmised, knowing how to use the technology is not sufficient on its own for usefulness or ease of use in integrating it into the classroom. Many participants of this thesis theorized that one issue may be that of teachers not knowing how to use the technology *effectively*. This corroborates research by Brown (2012), which found that teachers need to know of how to effectively use the technology in their instruction and to feel confident in their ability to use the technology.

Likewise, Li (2007) found that that teacher beliefs and values (as well as those of the student) must be thoroughly understood before technology initiatives take place. This thesis has examined participants' beliefs and compiled a working model of themes of requisite support needs for the successful integration of technology into teaching and classroom life, which include school board support, resource support, equipment, and other forms of support.

School board support.

There has long been a concern with developing teachers' understanding and use of technology. For instances, Jones and Mather (1995) and Compton and Jones (1998) noted that for teachers to become successful technology classroom practitioners, they and their professional development programs should focus on identifying, understanding the influences on, and further developing their own conceptualizations of technology education, technology pedagogy, and technological practice. An effective way to develop such areas includes reflecting on both one's own and others people's concepts of technology, pedagogical knowledge, and technological practices. This thesis has explored many of these areas. Similarly, a study by Judson (2006) revealed that professional development must enable teachers to access technology in ways that

support their proclaimed student-centered intentions. Many participants of this thesis focused on technology as being a natural vehicle to student-centered learning. As such, professional development that focuses on technology integration will inherently enable a student-centered approach to teaching. This is supported by research by Guzman and Nussbaumer (2009) who found there is a need to build training models that reinforce teaching competencies which support the incorporation of technology in institutional training processes, employing it as an integral tool with various uses and an inherent potential for promoting teaching and learning in diverse educational situations. In other words, like many participants of this thesis suggested, training models should focus on incorporating technology for its fundamental teaching and learning capacities.

When it comes to training strategies, Peart (2002) found that faculty favoured hands-on, step-by-step, user-friendly training with examples and practical applications that are appropriate for their discipline. The findings of this thesis concur with Peart's observations: all participants called for practical and useful training. Many participants in this thesis also discussed the time requirement for developing their (student-centered) competencies; likewise, ChanLin (2006) found that strategies that foster creativity require more time and collaborative effort for planning and implementing. Furthermore, understanding how to use technology to foster students' cognitive processes and creative thoughts is crucial to technology integration.

This thesis found that participants felt there was a lack of training available. All participants discussed limits with professional development (PD) days and the need for more mini tutorials. PD sessions were seen as too infrequent and too basic, there was a need for follow-up sessions, and a need to address gaps between application overview and practical application. These

findings echo previous research: Gülbahar (2007) proposed that the way to address the failure of effective integration of technology into curriculum is to make technology planning a *focus* of professional development. All participants of this thesis called for school board policy changes that focus on ensuring the viability of technology integration at all levels of support. While they did not explicitly call upon school principals to set a technologically friendly atmosphere within the school, one can infer that support at this level would promote integration initiative. These beliefs are supported by Lee and Lee (2010), who found that if a teaching environment strongly promotes technology integration, a teacher may feel inclined to adopt technology despite being unprepared, unwilling, or uncertain of its true value to their classroom objectives. In other words, it is expectation of the overarching context superimposed on the individual teacher which moves technology use into practical reality. This context is dictated to the teacher by a chain-link of authorities from supervisor, to school principal, to school board, to Ministry of Education. Of note, Lee and Lee (2010) found that the most basic wish to please one's superiors can move teachers forward to adopt technology.

All thesis participants explored the need for perpetual training and support as a goal to increasing teachers' technological capabilities. The study by Kim (2013) had a similar goal of increasing the technology capacity and competency of the teachers through continuous support. They found that the leadership of the principal and the scaffolding of their support provided teachers with the confidence to overcome their weaknesses and accelerated their strengths. Intensive, week-long summer training workshops were available, as well as on-demand workshops during the year. Their training sessions were designed to integrate web resources into lessons, to develop video recording and editing skills, and to learn how to maintain a web-based knowledge-sharing system. Participants in their study also received technical and pedagogical

assistance throughout the study. This assistance was given face-to-face, by phone, or by video-conference.

Participants did not single out in-school-based leadership per se, but did describe various ways that school boards can offer support, including increasing funding, policy changes, educational opportunities, and communication protocols. There is a fair amount of previous research which elaborates on issues of school board-based curriculum development and professional development needs related to technology integration. In a study by Gülbahar (2007), it was found that computers and new technologies are powerful tools that could be used for improving the effectiveness of instruction when used correctly. But to have technology-competent students, “teachers must deliver up-to-date technology-based curriculum and therefore must, themselves, also be technology-competent and equipped with the necessary knowledge and skills” (pg. 954). Thesis participants were resounding in their feelings that policy makers and professional development initiatives should *listen* to teachers’ requests and requirements viewpoints so that technology integration be optimal. This finding extends research by Lee and Lee (2010), which concluded that any planning of professional development programming or support for technology initiatives without considering all factors that determine a teacher’s decision to use educational technology will limit the potential impact of any training.

Because new tools emerge continuously in the realm of education and technology, training is an ongoing and permanent process (Jan and Contreras, 2011). Teo (2008) found that perceived ease of use and perceived usefulness do not remain static. As technology advances, teachers need to continually participate in professional development programs to “keep abreast with more advanced skills and knowledge on the use of computers, otherwise they may experience limitations in their efficiency” (pg. 137). Many participants within this thesis were explicit in

their concern for keeping up with technology changes as technology changes seem to increase exponentially. A technology's perceived usefulness and ease of use had some bearing on participants' integration of it and so did issues of time constraints, tech availability, and the slowed learning process when self-taught. All participants expressed concern for the time it takes to learn on one's own and, like Teo (2008), they extolled the need for varied, continuous, and advanced training modules.

In this thesis, all participants wished for more authority; they sometimes felt that they (the users of the technologies and PD services) were not given enough consideration at the policy level and that decisions makers and policy makers did not consult readily enough with their teachers. This thesis' findings corroborate earlier findings by Adams (2005), who conducted a longitudinal action study focused on teacher preferences regarding professional development models and technology integration. To address the concern of participants and those found in the literature, Adams (2005) found a need to link professional development programming with the technology integration needs of teachers, and by doing so, determined that more meaningful, well-developed, and sustainable teaching and learning experiences could be provided for long-term professional growth. While not all participants in this thesis expressed this *per se*, it is useful to note research by Szymanski and Morrell (2008) which proposed that effective professional development should be designed to assist teachers in selecting and using appropriate technology in their teaching and with students, meeting their curricular goals, and enhancing student achievement.

On a side note, two participants in this thesis noted their rank among their peers vis-à-vis technology integration, both feeling that their technological acumen made them different from their colleagues and that they embraced technology-based learning opportunities. This

corroborates research by Demetriadis, Barbas, Molohides, Palaigeorgiou, Psillos, Vlahavas, Tsoukalas and Pombortsis (2003) which found that teachers are interested in using Information and Communication Technology (ICT) to attain a better professional profile, as well as to take advantage of any possible learning benefits offered by ICT within in the context of the school culture.

Overcoming limitations and building teacher confidence comes down to providing useful and applicable professional development and training. This need is represented as an important factor to technology integration by thesis participants as well as in the literature.

Resource support.

All participants discussed the need for additional technological resource support within their schools. The kinds of resource support requested include: (a) technology professional learning community (technology-PLC), (b) technicians, (c) specialized instructional coaches, (d) consultants, (e) spontaneous peer support, and (f) outside expertise. These resources would influence how they actively use technology in the classroom and would also provide support for teachers who wish (but are wary) to integrate technology into their teaching. Previous studies have found that resource support is tremendously useful when attempting to integrate technology into the classroom. Thesis participants noted that historically instructional coaches were helpful when available. Kopcha (2012) had similar findings, noting that instructional coaches or mentors play a leading role in creating an environment of support that address the beliefs, skills, and support needs of teachers who are deciding to use technology. Studies by Cifuentes, Maxwell and Bulu (2001) and Adams (2005) have shown that when these communities and supportive

resources are made available, teachers continued to use technology for instruction over time and that continuous support and encouragement perpetuated an increase in teacher knowledge, skills, and abilities. By and large, according to this thesis, such communities are limited within this particular school board.

Many participants described strategies that had been put in place by the school board, some of which are now mostly defunct, such as consultants, technology PLCs, specialized instructional coaches, and teacher-to-teacher peer support initiatives. Along with previous research by Adams (2005), Kopcha (2012), and Szymanski and Morrell (2008) cited below, many participants in this thesis expressed the centrality of broad-based resource support to successful technology integration. Adams (2005) proposed the successful usage of a peer coaching program designed to support and encourage the growth of technology knowledge and skills. Peer coaching can be designed and individualized for the benefit of the teacher, the students, and the learning environment. Similarly, Kopcha (2012) supported the peer coaching design and added that the role of a mentor is to create an environment of support wherein the teachers' beliefs are acknowledged. In support of on-going support, Szymanski and Morrell (2008) acknowledged that one-shot approaches and seminars are not effective means of training teachers to use technology in their classroom. All participants in this thesis also noted the limits of "one-off" PD seminars as insufficient and lacking the potential for teachers to develop necessary skills or mastery.

All participants focused on their own self-reliance when it came to technology learning. Effectively, they were their own tutors and coaches in developing their technologically based lesson plans and teaching environments. This kind of initiative put thesis participants ahead of the curve compared to their colleagues. Of note, research by Belland (2009) found that until new

practices are as established and routine (as their prior practices were), teachers would be likely to perceive technology as an additional burden on their time. All thesis participants viewed time as being a complicating issue but felt that time spent on self-evaluation and reflection and time spent understanding and playing with technology was worth it, and indeed they advised these were important steps towards technology integration. This corroborates research by Ertmer and Ottenbriet-Leftwich (2010) which also found that providing time for self-assessment and “playing” with the technology may be essential elements to the longevity of technology integration.

As noted by thesis participants, much of their learning is self-taught and some commented on the potential and usefulness of a culture of peer support to move them forward in their teaching practice. Some lamented that a historic board-sanctioned initiative for peer support has gone by the wayside. Carr and Chambers’ (2006) findings similarly suggested a need for a cultural change in regards to (peer) sharing and reflecting on teaching practice of using online communication tools as an integral part of classroom teacher practice. In their view, schools do not adequately value collegial reflective sharing of practices, and classroom teachers do not use online communications tools as an integral part of their professional practices. Similarly, Putnam and Borko (2000) also note that collegial sharing of information and ideas about practice encourages teacher self-reflection and supported the risk-taking needed to transform teaching practice. Chikasanda (2013) found that on-going support, reflection, and feedback underpinned the professional development processes to enhance teachers’ prospects of putting aside old traditions and culture to implement new practices in their classrooms. Research by Adams (2005) also recommended scheduling regular teacher technology-sharing times that can be facilitated during the school day, after school, and during professional development training:

school communities will build higher levels of collegiality, community, collaboration, and camaraderie. These sentiments are echoed loudly by each participant of this thesis who called for the opportunity to collaborate with colleagues more than “once a year” and to have more advanced training on new technology. Ongoing collaboration is an important theme: Yuan and Ma (2008) found that providing teachers with a supportive environment through collaboration goes a long way in developing teachers’ positive attitudes towards technology and could have positive consequences in regards to their perceived usefulness and ease of use of technology in their classroom. This thesis, combined with the research findings from these five studies, reinforces the need for frequent peer support and training initiatives that include useful aspects of self-reflection and sharing of ideas.

All participants in this thesis noted that it takes time to integrate technology but that they are mostly working in isolation with technology (with the occasional spontaneous consultation with a peer) which takes them longer. While historically there have been attempts by schools and the school board to meet their needs, currently they are missing these formalized arrangements of support and opportunities for collaboration. Research by Walsh and Vannatta (2001) found that technology integration was a multifaceted process and that it takes time, support, and collaboration. Many years later, this thesis finds that these same variables are not yet met.

Equipment.

All participants spoke in generic ways about the need for support through financial investment in date technology equipment in the classroom. With old, outdated computers and only designated classrooms designed with lab technology, the opportunities to advance students learning through technology remains limited. Soloway (2000) found that competency in the use

of technology develops when tools can be called upon as they become relevant. Lack of exposure to tools limits advancement of technology skills. This belief was also reiterated by the quantitative response participants, all of whom are colleagues within the same board as the narrative participants. While there is much mention of poor and outdated equipment, there is little focus on its resolution. In a recent article out of the USA by Linder-Altman (2012), a three-year technology plan is equipping classrooms with up-to-date computers using a three-year lease model. Leasing appeared useful in providing up-to-date equipment and resources for students and teachers but findings of this thesis reveal that if training is not continually available, these resource still may not be used to their fullest potential.

Parents.

Many thesis participants also touched on the usefulness of parent collaboration as a unique form of support. They discussed the use of technology as a conduit for this kind of support. Teachers and parents can have a remote connection that is enhanced by technology to collaborate in the student's best interests. In Baskwill's (2013) book *Attention-Grabbing Tools for Involving Parents in Their Children's Learning*, she outlined how to use different communication tools to foster supportive relationships between teachers and students. She urged teachers to remember that: "not all parents have access to or feel comfortable with new technology" (pg. 95). While she does not mention technology initiatives specifically, her sentiment of proactive collaboration runs parallel with findings of this thesis.

Conclusions extrapolated from previous research, together with findings from this thesis include that: supportive environments influence attitudes to the positive; positive attitudes are

breeding grounds for openness, innovation, and adventure; technology and its use is more likely to be adopted and developed in this environment. Therefore, support is a necessary ingredient for the advancement of technologies in the classroom.

As a final note, Soloway (2000) specified that it is our responsibility as educators to create workplace conditions that enable, complement, and support teachers. Each participant in this thesis spent considerable time filling out questionnaire data and spoke with me on multiple occasions to help me develop a clear understanding of their experiences. Findings of this thesis highlight, for me, the fact that support is needed and important and that each participant's enthusiasm for what technology has to offer is obvious. Thesis findings expanded on the kinds of backing needed to make technology more central within the classroom and to help teachers feel more comfortable through gaining technology knowledge, mastery of skills, and developing a flexible style within the classroom to aid in managing the technological glitches that inevitably arise.

Teachers need to feel confident in their ability to use technology (Brown, et al., 2012). Through the narratives of the participants it is evident that there is a wealth of passion, abilities, and growing confidence among these teachers. I believe there is value in this thesis but it is not without limitations.

Thesis Limitations

This section describes two areas of potential limitation within this thesis that need to be addressed: (a) choice of methodology, and (b) design limitations.

Choice of methodology.

This research thesis used a mixed method approach. The lion's share of the study utilized Narrative Theory's Methodology to glean a depth and richness of study participant experiences. A quantitative tool, the *General Technology Usage Questionnaire* (GTU), was developed and used to obtain demographic information and technology use information using a 5-point Likert scale. As well, an initial interview protocol was developed based on an overview of the literature and research frameworks focused on technology integration. These include the Technology Acceptance Model (TAM) which has a high validity rating and focuses on how users of technology come to accept and use technology, and Narrative and Inductive Coding strategies based on research by Creswell (2012; 2013) and Miles and Huberman (1994).

I believe the Narrative approach was the best method to use in reporting on the teachers' perceptions because it enabled a wealth of rich information to be analyzed. One potentially major limit to this method: A different researcher might examine the raw interview data and analyze a different set of themes. In other words, another researcher may draw a different set of conclusions. I think that the beauty of the narrative design is that it seems to be inductive rather than deductive; it seeks to create a set of ideas rather than a set of conclusions. To me, this does not mean that the research here would be rendered invalid, but rather that my academic perceptions, as researcher have unique (and perhaps generalized) relevance and integrity in the research area.

Having said this, I nevertheless need to address methodological weaknesses, including:

Relevance or utility to a community of scholars: whether the topic is important and the findings make a significant contribution to the knowledge of the field. I believe the topic is important and the findings contribute a unique perspective of teachers' perceptions to the field of education.

Truth or validity: whether the finding are representative of the features of the phenomenon it is intended to describe, explain, or theorize, the findings are rich of the first hand experiences of teachers using technology. The narratives provide an in the moment glimpse of how local teachers are using technology in their classroom. For instance, while the *GTU* questionnaire asked about a specific set of limitations (and participants checked the boxes based on this set), in actuality, the interview process illuminated a much more thorough and complex set of limitations which quantitative data would have missed.

Design limitations.

This is a small thesis in a comparatively small school district. As such, there are some design weaknesses. These include: sample size, non-random sample, data collection methods, environmental limits (not being able to conduct face-to-face interviews), confidentiality limits, research rookie limits, study focus limits, conceptual ambiguities or overlaps, and (ironically) technology malfunctions.

Sample size.

The number of participants is low (five) in comparison to the school board secondary teacher population. This limits the generalizability of the results of this study. The five teachers interviewed fell into specific predetermined criteria to obtain individuals with the longest number

of years of experience with technology usage and integration. For future research, a large sample size would be preferred. This could be delivered in the form of an in-person questionnaire delivered as part of a professional development activity, focus group, or individual interviews.

Non-random sample.

These interview participants were selected based on their knowledge, experience, and professional capacity in regards to technology usage as specified as important by the researcher. Based on the results of the descriptive and inferential analysis, the five teachers chosen also represented a non-probable sample and, therefore, cannot be assumed to be a fair representation of the teaching profession based on demographic information collected alone.

Data collection methods.

Data was collected using a quantitative questionnaire format as well as an interview process which was completed over three different interview times. Additional data collection methods such as classroom observation, pre- and post-technology usage surveys, examination of lesson planning material, focus-group discussions, or professional development meetings, would add more depth to the quantitative and qualitative methods.

Environmental limits.

The school environments of the study participants varied in regards to their values and academic focus and available equipment. These factors, especially equipment availability, would likely impact participant experiences and can be noted but it is hard to know how much of an influence this would have on technology integration and acceptance on individuals.

Confidentiality limits.

School profiles were taken into consideration when describing the teaching and learning environment but contained too much identifiable information to be included in the main body of this study due to confidentiality limits. Limiting this information did not allow me to describe the complete external environment that could influence the responses each teachers describes.

Research rookie limits.

There are a few limits that are caused by my interviewer novice – questions I might have asked but didn't – so information was lost. Upon reflection of the process, small changes to this study would benefit a second research project's data collection. Looking at the demographic information of my interview participants obtained from their questionnaire responses, possibly important information was not asked of them. Participants were interviewed in May 2014 and it was not asked how long they had been teaching at their present school. I did not inquiry about whether or not their current position was full-time, part-time, or a long-term occasional contract. I also did not ask them if they were a department head or associate teacher (involved in pre-service teacher training and mentoring). Having this information verified by the participants may have helped to give more context and background to their usage of technology.

Study focus (technology perceptions and acceptance) limits.

Within the concept of technology acceptance – the usefulness and ease of use of technology was asked directly only *once*. The interviews were designed to establish the past, present and future uses of technology of each participants and how their experiences influenced their

perceptions in regards to technology integration. Perceptions about the future use of technology is seen as pertinent because imagining the future is most often built on relevant present and past experiences. The participants' experiences served as the foundation for their many thoughts about the future of technology and its integration. This thesis was not designed to determine technology's usefulness or ease of use; nor to determine thinking about what is important in teaching and learning. These factors are imbued within participants' responses but are beyond the scope of this thesis. Participants shared a wealth of data and future studies could look at the individual and personal factors that further influence their perceptions of the usefulness and ease of ease of technology through classroom observation.

Conceptual ambiguities and overlaps.

Participants are first and foremost teachers, and this is more primary than title of technology user. The questions asked centered on technology use and then the teachers talked openly, without limits. The answers given can fall under two categories, that of teacher and that of technology user. Separating these categories may be nearly impossible. Questions remain about overlap. While the distinctions are obvious in some areas such as technology use, in other areas such as classroom management, the distinction is less clear. Questions remain about what makes participant answers so different from the answers that teachers who do not use technology might give. This question constitutes a possible limitation, and yet, it is what it is. The study represents data as spoken by teachers who use technology, so by virtue of this fact alone, the data has relevance.

Technology malfunctions.

Rather ironically, technology malfunctions appeared and reappeared throughout this thesis. As noted by study participants, this is part of what one accepts when they choose to use technology on a day-to-day basis. The process of thesis writing is no exception. At times I fixed the glitch, sought technical expertise, or reverted to the tried and true method of paper and pen. In the future, I will use the iCloud tool to bypass hardware malfunctions by having my work accessible online and not at risk if my computer fails. Patience, adaptability, and tenacity seem to go hand in hand with all new endeavors.

Chapter 9: Conclusion

In conclusion, throughout fairly extensive discussions with the five experienced teacher participants in this thesis, it became very clear that life in the classroom is dynamic and vibrant. Each participant described their personal and unique styles of implementing technology, relating to students, and managing classroom difficulties. Each saw themselves as evolving through the use of technology, and this evolutionary process as influencing their attitude towards increasing openness and exploration with technology and also with their students. While their motivations differed, each described a shift in their teaching orientation from teacher-centered to student-centered. Each participant developed their own practical style of handling the in-classroom glitches that complicate lesson plans, and all seemed comfortable and confident in figuring things out as they went along. Technology forced them, so to speak, to evolve a flexible style of managing. In true form, this open and flexible style is wonderful role modeling for students and other teachers with different pedagogies. A day in the life of a technologically integrated classroom with technologically savvy teachers means that teaching strategies change and teaching evolves.

It is ironic that while conducting the second interview with Randall, my computer decided to shut down and I could not access my questions or recording device. This forced me to end the interview prematurely, reboot my computer and deal with a whirl of emotions ranging from embarrassment, frustration towards my computer, and most predominantly, annoyance for lack of foresight in considering potential technology glitches. I imagine that such feelings would be compounded with this happening in front of a classroom full of students. Throughout the analysis and writing of this research paper, there were many frustrating nights due to glitches and

software malfunctioning. My experience parallels those described by study participants of this thesis, though theirs are more elaborate.

All participants had personal stories about the limits or constraints of incorporating technology into the classroom. These limits ranged from technological limits and glitches at micro and macro levels (hardware troubles, school board barriers, overarching limits related to structures and systems external to the school organization), to personal and professional limitations, to complexities related to students learning, to practical limits. Many participants were candid in frustrations yet all were generous and optimistic in their outlook. I came to feel that each viewed themselves, whether they realized it or not, as a pioneer for a new way of teaching and a new way for student learning. I certainly saw them as pioneers.

Technology is an ever-evolving enterprise and it presses teachers and students alike to grow and develop just to keep up. For teachers, charged with lesson content and all of the other stresses of work life and personal life, it can add tremendous time pressures and competency demands and anxieties. All participants seemed different than their colleagues in their embracing of change and seeing technology's potential usefulness. For them, the self-imposed learning curves of understanding and using technology seemed to present challenges and a degree of satisfaction which comes with increasing mastery. Nonetheless, all were clear that support of their endeavors would be helpful and that integrating technology into the classroom structure was essential. They each spoke about the kinds of support that they deemed most necessary and these broadly subdivided into support from the overarching authority of their school board, hands-on resource support, and other forms including parental support and a wish list of ideals such as ongoing technology upgrades and classrooms which are fully tech-integrated.

This thesis also recognizes the dynamic changes that take place within and between technology users. Both students and teachers seem to experience transformational shifts within themselves as well as role shifts within the classroom setting.

Participants had great hope for the future. Their perceptions shape their classrooms and their students' learning. We do not live in a utopian world and money available to any public institution can never really satisfy the intense demands placed on that institution. How exactly technology will become integrated within the classroom of the future, we will learn as we go along. When practical limits bump up against the huge wave of potential, somehow potential finds its way. These science teachers are on the forefront of progress. They, along with their students, will continue to push the rest of us and teach us about our future.

This thesis was designed to better understand the perceptions of experienced teachers, in regards to technology's usefulness, ease of use and effective integration in the classroom. The following section will discuss the implications of research and the recommendations for practice, as well as specific limitations of this thesis.

Implications of Research

I believe the theoretical and conceptual frameworks and the methodology of this research can be used as a model of inquiry for further research. This thesis could be used as a foundation for future research or postdoctoral research; topics as recommended below:

1. A repeat of this same study with same methodology but larger sample size and across pedagogies to glean additional information and clarify legitimacy of established themes in this thesis.

2. Additional research to concentrate on some of the specific areas of focus within this thesis including:

- Constraints and limitations of integrating technology. Each of the themes could be a study in its own right: technology constraints, teacher, personal, and professional limits, student limits, practical limits.
- Strategies for teaching using technology. Each theme warrants more analysis: attitude, shifts in teaching orientation, classroom management, use of technology tools, participant-observer strategies.
- Supports for technology integration. A study focused on shifts in use of and attitudes towards technology as it becomes more integrated into the school system would be a fascinating and worthy study. This could include administering a more advanced form of the General Technology Usage (GTU) questionnaire prior to technology integration and the same GTU questionnaire post-integration, and conducting a statistical analysis on the findings.
- Research investigating changes in school board protocols vis-à-vis technology would also be very useful. Research could focus on changes or initiatives in (a) Funding: how available funding is used; lack of sufficient funding; choice of who decides how the funding is spent; (b) Policy; (c) Professional Educational; (d) Communication protocols.
- Research following the implementation of specific initiatives and tools to evaluate their effectiveness would have practical value to school boards and funding bodies.
- When linking thesis findings with previous research, some gaps in research include: (a) student limits in adopting technology; (b) use of students as tech assistants, (c)

- establishment of teacher post-work boundaries; (d) parental collaboration in teaching, and (e) strategies for tech equipment updates. These may be worth further exploration.
3. Of particular interest to me is designing a longitudinal action research study similar to those of Adams (2005), Kim (2013), and Niess (2005). My thesis overlays with their research which calls for a mentorship approach and hand-over-hand method of integrating technology. In my next study, data would be collected over a series of years to establish a professional development program focused on technology integration in the context of science pedagogy. Teachers would be provided with consistent instructor-led, hands-on instruction, supported by mentors, peer coaches, and involved in teacher technology-sharing opportunities. Quantitative changes in teacher confidence, technological skill, glitch savvy, effectiveness, and student learning could be used as measures. This kind of study would provide a wealth of influential data that could then be implemented directly in line with the school board initiatives.

After the completion of this thesis, I would like to work with the school board to develop training programs for teachers that go beyond the surface of technology acceptance and expand on both the quantitative and qualitative findings of this thesis and uncover a new understanding of the perceptions of teachers with little to no technology in regards experience or usage.

Recommendations for Practice

In true narrative fashion, I wanted to include the recommendations for practice from the participants themselves. They are the experts and I view myself as simply the amalgamator of

their data.

The participant responses have value in understanding:

- Technology adoption strategies.
- The constraints and limits of technology.
- The kinds of supports that are needed to enable teachers to effectively use technology.

As well, this thesis adds value in understanding:

- Teaching evolution more generally.
- Teacher attitude and resiliency.
- Current usage of technology tools.
- In-classroom reflexive teaching modifications.

In a practical way, this thesis has implications:

- For teachers wishing to integrate technology into their classrooms.
- For school boards and policy makers.

In a research-focused way, this thesis has implications:

- For developing new categories and lenses of understanding.
- The beginnings of theory model making.
- Gaps in current research which could be fulfilled (for instance: student resistance to technology, on-line technology and implications on teacher boundaries, and usefulness of parent collaboration).

The teachers in this thesis lead the way within their school board for integrating technology into their classrooms. This makes them different and in some ways more technologically innovative than their colleagues. As such, their perceptions of their experience can provide useful and practical recommendations for technology usage and integration for those of their colleagues who have not integrated technology into their classroom teaching.

There are four broadly based levels of recommendations, addressing:

- Technology training and development.
- Technology integration and policy considerations.
- Teacher self-initiative and finally.
- Research focus.

Technology training and development.

For teachers who are not using technology as regularly in their lessons, providing opportunities and training to overcome their limited usage is the first step to helping them achieve long-term success with technology. The topmost questionnaire responses to the factors that hinder the use of technology were lack of training and support, time, and integration ideas. The following are suggestions for future research focus or a lens for an action plan based on participant responses and current literature:

- i. *Continuous professional development:* When it comes to increasing technology integration, *continuous* professional development specifically focused on technology should be implemented.

- ii. *Teachers' voice*: Teachers should be involved in their professional development.
- iii. *Balance between encouraging and pushing*: Teachers need to try new things and respect that it takes time to learn and become comfortable and that everyone has different comfort levels.
- iv. *Staggered training*: Schools should provide modules which add increasing levels of knowledge and skill
- v. *Pedagogically focused training*: Subject-specific technologies and applications training should be developed (Niess, 2005).
- vi. *Transferrable and Adaptable training*: Training should be transferrable to other classes and subjects.

Technology integration and policy considerations.

Participants in this thesis are 'techno-converts'. As such, they have a basis of knowledge through which to voice specific recommendations to aid in technology becoming better integrated into the school system. These recommendations include:

- vii. *Appropriate technological equipment*: If usage is justified from a pedagogical point of view, board should not resist its usage.
- viii. *Teachers' voice*: Teachers should have an advocacy role when it comes to new technologies.
- ix. *Improved Teacher and School Board dialogue*: The school board needs to be prepared to listen and respond to strong arguments.
- x. *Increased Funding*: Financial support should not be so restricted.
- xi. *Improved School Board communiqués*: More accessible and transparent information

and communication should be available from the school board.

- xii. *Time*: Some consideration (in terms of flexibility, lieu time, financial compensation) should be given for extended time needed to prepare lessons, present technology focused meetings, fix glitch issues etc.
- xiii. *School Board formal support for collegial connections*: Board-sanctioned opportunities should be available for technology discussions with colleagues.

Teachers and self-initiatives.

This thesis used the notion of *ease of use* and *usefulness* as defined by Davis (1989) as tools by which to begin to understand teachers' perceptions of technology. This thesis has discovered that there are many nuanced factors which impact teachers' perceptions of technology and its integration. When it comes to the perceptions of technology usefulness and ease of use, it is clear that the participants of this thesis regard technology usage as a long-term useful tool that can assist and aid their teaching strategies and instructional delivery. The ease of use, however, is dependent on each individual's personal beliefs and abilities. Confidence and comfort in any activity only comes with exposure and practice. Some participants in the thesis had exposure and practice long before they became teachers; other participants made an active decision to develop their knowledge and skill level. Recommendations made directly to teachers include:

- xiv. *Attitudinal Tenacity*: Change happens, embrace it, learn and expect errors.
- xv. *Invest in self*: Invest one's own time and grow in skill and self-assurance and self-reliance.
- xvi. *Self-assessment*: Take time to evaluate how one is doing in order to self-correct or seek those who can teach skills based learning.

- xvii. *Balance*: Find a balance in personal and professional time where technology skills can be practiced and where, at other times, technology and school-related matters can be put away to enjoy life.
- xviii. *Seek experts*: Teachers that love technology are generally enthusiastic sharers of their knowledge. Find mentors.
- xix. *Make communities*: There is great importance in community and togetherness. Search out opportunities to divide and conquer the workload of subject and pedagogy specific technology integration strategies.
- xx. *Play!*: Don't be afraid of technology. It is meant as an aid in life and a gateway to new forms of learning

Summary and Researcher's Reflections

The purpose of this thesis was to shed light on how the perceptions experienced teachers, in regards to technology's usefulness and effective integration. Since perceptions are multifaceted, vary from person to person, and are influenced by the individual's experiences, it was important to understand how teachers' experiences influence their perceptions. This thesis also examined three secondary or supporting research questions focused on (a) specific limitations and constraints affecting participant's attempts to incorporate technology; (b) specific teaching strategies participants perceived to be useful when incorporating technology; and (c) specific supports participants perceive as being necessary for the incorporation of technology.

Each participant was chosen based on their technology usage at the time. All participants used technology a minimum of five hours per week in their classroom. The narrative approach

was utilized to examine and showcase the lived experiences of the participants and their everyday successes and frustrations with technology. My hope was that this thesis had the potential to provide insight into how teachers regard technology and whether the level of integration is dependent on perceived usefulness and ease of use of the technology tools with which they are provided.

The TAM was adopted as the guiding frameworks and foundations for the development of a questionnaire and interview protocol. This framework was used in previous research to explore the lived experience of the teacher's perceived acceptance of technology. The TAM had strong merit as a quantitative tool for answering hypothesis and factorial data. For this reason, I specifically used this framework to guide the development of my General Technology Usage (GTU) questionnaire.

This thesis found that, for its participants, the TAMs of perceived usefulness and ease of use of technology did have an impact on the integration of technology within the classroom. Based on these models, the *GTU* questionnaire proposed that time, lack of training, integration of ideas, and access to technology (devices, computer labs, hand-held data collectors, etc.) would be seen as limits to technology integration. Twenty respondents concurred with: 85% time, 70% lack of training, 45% integration ideas, 35% lack of support, 25% availability of devices. When technology is perceived as useful and easy to use, it is more likely to be used within the classroom. This, however, is only part of a complex puzzle. It does not seem necessarily to be a cause and effect relationship. A technology's usefulness and ease of use are not sufficient to guarantee integration into the classroom. This thesis conducted three in-depth interview with five participants, all of whom recounted a number of mitigating factors to using and integrating technology. Limits and constraints to integration were subcategorized into four sections:

technology glitches, teachers' personal and professional limits, student limits, and practical limits.

Further, this thesis focused on participants' perceptions of teaching strategies used when using technology. This comprised participants' response to direct questions of 'strategy' as well as incidental commentary. Definitions for 'teaching strategies' included (a) what approaches (behavioral, emotional, cognitive) teachers used in order to incorporate technologies into the classroom; (b) how technology effected teaching methods; and, (c) how technology was being used to support a teacher's pedagogical needs. A nuanced array of themes emerged for teaching strategies, which included attitude (technology as shaping teaching attitude), shifts in teaching orientation, changes in classroom management and teaching strategy (prep, in-class, post-class management), practical tech-glitch management, choice of tech tools, and participant-observer strategies.

Finally, this thesis was able to discern some clear necessary supports as generated through participant interviews. These included (a) school board supports, (b) resource supports, (c) equipment supports, and, (d) parents. These supports have been amalgamated into a list within the recommendations section.

In brief, this thesis is useful to the education and research fields because few research studies focus on the experiences, attitudes, and motivations of the teacher in regards to accepting technology into their teaching styles. It is the overall intention of this thesis (a) to provide a truthful and trustworthy account of local teachers' perceptions of new technology through a narrative approach, and (b) to assist in the local school board's aim of having fully mobile and user-accessible technology environments within their schools.

By discovering how experienced teachers are using technology through the narration of their shared stories and the exploration of their perceptions, I have been able to understand and identify a variety of factors influencing the level of technology integration; these include external factors such as school board policies, technology tools, school board and classroom practices, support structures, work/life pressures. I have also elucidated internal factors influencing the techno-savvy teacher including skills levels, personal history, and personality attitude. I have proposed future areas of focus that support teachers and improve the level and value of technology integration. I am in agreement with Macdonald (2008) that if we want to effect lasting educational change, those involved in the education process (whether they are members of the school board or board of trustees, teachers, educational assistants, librarians, parents or, in fact, students) must all come together and share the common goal of technology acceptance.

Researcher's reflections.

I have been fortunate to have lived a double life up until this point. In October 2015, I turned 30. Growing up in the mid-1980s and early 1990s, I learned through play at home and through lessons and direction from my teachers at school. I learned through experience and failure. I learned through repetition and memorization.

At age 10, I can still remember the first computer that our family owned. We had a 13-inch TV that received five channels and a Compaq computer with a 15-inch monitor that had a lot of limits. Society was much different 30 years ago. Back then, not every family had a computer. Our games were on floppy disks and I am confident that this technology system is so antiquated that most students today would not know of its existence, let alone its process of use.

Computer technology has come a long way from when I was young. Students today are

growing up within an ever-changing world of technology dependency. Today's family may have one or more televisions in the home and multiple computers and/or gaming systems and mobile devices. Their access to technology is much greater than mine was growing up.

I was first interested in this topic because I wanted to understand how new technology could benefit my teaching career. As I have gotten older, I have thought of myself as fairly tech savvy. I stay current and up-to-speed with new technologies but I am lacking the experience of using the technology within the classroom. With so many different platforms, applications, simulations, and options available to teachers, I wanted to understand how teachers used their chosen technology tool(s), why they chose a particular tool, and what struggles they faced. I have never thought of teaching as a career path that could be copied. So much is based on the individuality of the teacher. As such, each teacher has much to offer the others. I have tried to learn from and share with my colleagues.

Based on my prior knowledge and experience with technology, I do not believe that technology should be considered as a replacement to the teacher, but instead should be used in tandem. It is realistic to say that those teachers who embrace technology will potentially replace those teachers who do not, but I do not believe there will come a time when teachers are replaced completely. Teachers need to find the balance point that fits with their abilities and teaching style. I took small steps and tried a number of different technologies before I found ones that I liked and could use effectively. With the rate at which technology changes and advances, by the time I get my own classroom as a permanent day school teacher, newer and better technological tools will be available and I will adapt my teaching methods accordingly.

I have gained so much useful knowledge throughout this research process. The development of the proposal was a lengthy process and the completion of the thesis an even larger one,

especially with two small children at home. I received a wealth of useful data from my participants and it took time to transcribe and become familiar with the conversations to write their narratives truthfully. I hope that my consistent immersion into my data shows through in my findings.

It is clear from this research that teaching needs to be seen as a collaborative profession. We are all learners and we are all teachers; we can help each other if given the opportunity.

This is true for technology integration and it is also true of learning to conduct research and to write a thesis paper. Mentorship, guidance, exposure, skills training, patience, and tenacity are hallmarks of every teacher and every student.

Kieran Faw

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Appendix A: Quantitative Tool

Technology acceptance questionnaire.

Short Answer Questions:

1. What courses are you currently teaching?
2. What school are you teaching at?

Multiple Choices Questions:

3. Gender

- a. Male
- b. Female

4. Age

- a. Under 25
- b. 25 – 34
- c. 35 – 44
- d. 45 – 54
- e. 55 and over

5. How many years of teaching experience do you have?

- a. Less than 5 years
- b. 5 – 14 years
- c. 15 – 24 years
- d. 25 – 34 years
- e. 35 and over

6. How many years of experience do you have using technology?

- a. Less than 1 years
- b. 1 – 2 years
- c. 3 – 4 years
- d. 5 – 6 years
- e. 7 and over

7. How many hours a week do you use technology in your teaching practices?

- a. 1 hour or less
- b. 2 - 4 hours
- c. 5 - 7 hours
- d. 8 – 10 hours

e. 10 or more

8. What hinders you from trying new technologies? Please check all that apply.

- a. Lack of training
- b. Lack of support
- c. Time
- d. Planning
- e. Integration ideas
- f. All of the above
- g. Other:
- h. Other:
- i. Other:

Scale Questions: Never (1 to 5) Extensive Use

9. In the past academic year, rate the degree to which you used presentation software as an instructional technology tools (such as Powerpoint)?

10. In the past academic year, rate the degree to which you used spreadsheets as an instructional technology tools (such as excel)?

11. In the past academic year, rate the degree to which you used Internet content as an instructional technology tools (such as web-based articles or searches)?

12. In the past academic year, rate the degree to which you used audio as an instructional technology tools?

13. In the past academic year, rate the degree to which you used video as an instructional technology tools?

14. In the past academic year, rate the degree to which you used animation as an instructional technology tools?

15. In the past academic year, rate the degree to which you used discussion boards as an instructional technology tools?

16. In the past academic year, rate the degree to which you used blogs as an instructional technology tools?

17. In the past academic year, rate the degree to which you used wikis as an instructional technology tools?

18. In the past academic year, rate the degree to which you used podcasts as an instructional technology tools?

Scale Questions: Strongly Disagree (1 to 5) Strongly Agree

19. The use of technology in education can enhance student learning in my discipline.
20. The use of instructional technology can enhance my teaching.
21. I have adequate training opportunities at my institution to develop the technical skills required for instructional technology integration.
22. The administration in my school supports my use of technology in education.
23. I have access to instructional technology technical support.
24. Instructional technology is important in high school education.
25. I change my teaching plans and strategies to foster student learning.

Short Answer Questions:

26. Do you have any professional or personal website(s) you are willing to share? Please provide links.
27. Do you subscribe to any professional development or personal websites? Please provide links.
28. How has your teaching changed because of technology? Please provide examples
29. If you have experience using technology in your teaching and learning practices a minimum of 5 hours per week and would like to participate in follow-up interviews, please provide your contact information. *(Please note that not everyone who provides contact information for interviews will be contacted)*

Appendix B: Qualitative Research Tool

Interview protocol: Initial interview.

Teacher:

Location:

Grade/Subject:

Date/Time:

1. Could you describe your experiences in acquiring technology knowledge and skills?
2. What types of frustrations or limitations do you experience in trying to use technology in your teaching?

What types of problems or barriers do you experience in integrating technology into your curriculum?

3. How do you try to overcome these frustrations or limitations?
4. Which types of teaching strategies appear to be most successful when you are using technology?

How do the teaching strategies of your lessons change when you are using technology?

How does classroom management change when you are using technology?

5. How long do you think it will take you to infuse technology into your teaching in the way you envision it?
6. How is technology changing the way you teach?
7. What types of support would help you continue your progress in using technology in your classroom?

Interview protocol: Second interview.

Teacher:

Location:

Grade/Subject:

Date/Time:

1. Using technology in your teaching can take additional preparation time and sometimes be frustrating, so why do you use technology tools in your teaching?
2. How do you feel about the time investment you are making to learn and incorporate technology into your teaching?
3. What advice would you give to a teacher who has a desire to begin the process of including technology in their instruction?
4. In what ways might you be different from the teachers who aren't integrating technology into their instruction at this point?
5. Explain how you decide whether an instructional strategy using technology was effective or not.
6. Describe your role in the classroom when teaching with technology? Change? Is that a change for you?
7. It seems that teachers learn about technology as it happens or just in time learning rather than thorough instructed learning. Why do you agree or disagree with this statement?
8. How do you think future upgrades of software and hardware will affect your lesson planning and teaching?
9. Identify the most important factor or factors that will determine whether you continue to plan for and use technology in your classroom lessons.

10. Please describe an example of a technology problem that you experienced in the classroom.

How long did it take you to solve it?

Did you need anyone to help you solve it?

11. Technology glitches can be everything from machine problems to just not having the right cable to connect something. How do you feel about the technology glitches that you encounter in teaching with technology?

What role do these glitches have in the process of teaching with technology for teachers?

12. What are your worst fears about this process of incorporating technology into your teaching?

13. What are your best hopes for this process of incorporating technology into your teaching?

Interview protocol: Final interview.

Teacher:

Location:

Grade/Subject:

Date/Time:

1. What advice would you give policy makers or administrators on implementing and integrating classroom technologies?

What role should teachers have in developing classroom technology or apps?

What do you think the future classroom will look like?

2. Do you believe technology has/could have a negative impact on the teacher-student relationship/roles if not used correctly?

Do you or have you ever had any reservations towards using it?

Do you feel there are strong risks to integrating technology too quickly or too blindly?

3. In your own words how would you describe the usefulness and ease of use of technology in your classroom?

4. When faced with a challenge, 'giving up control' may be easier said than done. What are the mental steps you take to achieve this? (For example, glitches - when the internet fails, hardware crashes, compatibility issues – roll with the punches and relax)

How long has it taken you to become comfortable with this?

What advice would you give other teachers to 'give up control' when using technology with their students?

5. How important are the students to the overall success of technology integration? Should the board or the Ministry of Education be taking different steps other than a focus of 'bring your own device'?

Appendix C: Questionnaire Letter of Intent

Letter of Information

Project title: Striving towards an understanding of experienced teachers' perceptions of the usefulness, ease of use and effective integration of technology in their classroom

Names of researchers and contact information (Names have been taken out for privacy reasons)

Invitation to Participate: You are invited to participate in a research project conducted by the Thesis student under the supervision of the Thesis supervisor as part of her Master of Arts in Education (MA. Ed) at the University of Ottawa.

Participation: If you wish to participate in this study, please complete the attached survey. Your decision to complete and return this survey will be interpreted as an indication of your consent to participate. The survey should take you approximately 10 minutes to complete. You do not have to answer any questions that you do not want to answer. Once you have completed the survey, please return it in the stamped self-addressed envelope provided. We would appreciate receiving it before January 24th, 2014. If we do not receive it by said date, we will send you a notice of reminder.

Purpose of the Study: The purpose of the study is to shed light on how teachers perceive the usefulness and ease of use of technology as a teaching and learning tool in their classrooms.

Benefits: By taking part in the questionnaire, your experiences with using technology in your classroom you will contribute to an enlarged understanding of the subject from the perspective of a practicing teacher.

Privacy of participants: All information shared with the Thesis student will remain strictly confidential. Your identity will be protected. The contents will be used only for this MA. Ed thesis only.

Confidentiality and Anonymity: The information that you will share will remain strictly confidential and will be used solely for the purposes of this research. The only people who will have access to the research data are Thesis student and Thesis supervisor. Your answers to open-ended questions may be used verbatim in presentations and publications but neither you (nor your organization) will be identified. Results will be used to support data analysis and identify potential participants for fewer interviews. Anonymity is guaranteed since no identifying personal information will be published in final thesis document.

Conservation of Data: The questionnaires will be kept in a locked filing cabinet in the office of the Louis Trudel at the University of Ottawa for a period of 5 years at which time they will be destroyed.

Voluntary Participation: You are under no obligation to participate and if you choose to participate, you may refuse to answer questions that you do not want to answer. Completion and return of the questionnaire by you implies consent.

Acceptance: I, _____, agree to participate in the above research study conducted by (name has been removed) as part of her MA. Ed thesis at the Faculty of Education, University of Ottawa under the supervision of Thesis supervisor (name has been removed).

If I have any questions regarding the ethical conduct of this study, I may contact the Office of Research Ethics and Integrity, University of Ottawa, Tabaret Hall, 550 Cumberland Street, Room 154, Ottawa, ON K1N 6N5

Tel.: (613) 562-5387

Email: ethics@uottawa.ca

There are two copies of the consent form, one of which is mine to keep.

Participant's name

Signature:

Date:

Researcher's name

Signature:

Date:

Appendix D: Interview Consent Form

Consent Form

Project title: Striving towards an understanding of experienced teachers' perceptions of the usefulness, ease of use and effective integration of technology in the classroom

Names of researchers and contact information (names have been removed for privacy reasons)

Invitation to Participate: I have been invited to participate in a research project conducted by the Thesis student under the supervision of the Thesis supervisor as part of her Master of Arts in Education (MA. Ed) at the University of Ottawa.

Purpose of the Study: The purpose of the study is to shed light on how experienced science teachers perceive the usefulness and ease of use of technology as a teaching and learning tool in their classrooms.

Participation: My participation will consist of participating in a maximum of three interviews about my experiences with using technology in my teaching and learning practices. The time needed for this is approximately 45 minutes. This will take place at a time and location convenient to me. The Thesis student will audio-record my responses.

Assessment of Risks: My participation in this study entails no foreseeable risks. However, if I experience any discomfort, the Thesis student has assured me that she will make every effort to minimize this discomfort. I may decide to stop the interview at any time.

Benefits: By expressing some personal ideas about my experiences with using technology in my classroom, I will contribute to an enlarged understanding of the subject from the perspective of a practicing teacher.

Privacy of Participants: I have received assurance from the Thesis student that the information I share will remain strictly confidential. My identity will be protected. The contents will be used only for this MA. Ed thesis.

Confidentiality and Conservation of Data: I have been assured that the audio recording will be kept in a secure manner at the researcher's home during the research, and upon completion of the project will be stored by Louis Trudel at the University of Ottawa. The data will be kept for one year following the completion of the thesis in December 2014. In December 2015, all material data will be shredded and electronic data will be erased.

Voluntary Participation: I am under no obligation to participate and if I choose to participate, I can withdraw from the study at any time and/or refuse to answer any questions, without suffering any negative consequences. If I choose to withdraw, all data gathered until the time of withdrawal will be destroyed.

Acceptance: I, _____ agree to participate in the above research study conducted by (name has been removed) as part of her MA. Ed thesis at the Faculty of Education, University of Ottawa under the supervision of Thesis supervisor (name has been removed).

If I have any questions regarding the ethical conduct of this study, I may contact the Office of Research Ethics and Integrity, University of Ottawa, Tabaret Hall, 550 Cumberland Street, Room 154, Ottawa, ON K1N 6N5

Tel.: (613) 562-5387

Email: ethics@uottawa.ca

There are two copies of the consent form, one of which is mine to keep.

Participant's name

Signature:

Date:

Researcher's name

Signature:

Date:

Appendix E: Additional Information on Tools

Applets: i.e. General physics Java applets' can be downloaded and stored onto classroom computers (eliminating the need for faulty/unreliable Internet connections). They will only run however with a Java plug-in (additional software which needs to be downloaded and this may/may not be possible depending on school/computer firewalls).

Clickers: Are devices for recording responses to multiple choice or yes/no questions. There are many different Clicker suppliers on the market. They allow for formative and summative assessments as well as immediate feedback from students which allows the teachers to alter/tailor the remainder of the lesson accordingly. Application for mobile devices can transform a cell phone into a clicker eliminating the need for multiple sets of different classrooms.

(<http://www.engaging-technologies.com/classroom-clickers.html>)

Chromebooks: is a web based application platform which works very with Google Presenter using voice-to-text, text-to-voice technology without having to put on any other applications. Chromebooks are also a lab top that has Google operating software known as Chrome OS (instead of Window or Mac OS). They are designed to be used primarily while connected to the Internet. They have limited internal memory as most of their application and documents are uploaded to the users Google Drive account. This feature makes Chromebooks useful for classrooms and schools. At one particular school, carts of laptops and Chromebooks are available for “rental” or sign-out by teachers or individual students. Students log into the devices with their google-student id accounts and save all of their material to their google drive accounts so that they can continue to work on their assignments at home.

E-mail (Yahoo, Hotmail, Google): Students have different email accounts outside of the classroom; historically students have required a new email account for each class because teachers may use different platforms. Recently the school board made the switch to the Google platform, teachers and students are automatically provided with a Gmail account (email on Google) thus perhaps reducing the need for multiple accounts.

Geometer's Sketchpad: The Geometer's Sketchpad® is software for teaching mathematics. Sketchpad® gives students at all levels - from third grade through college - a tangible, visual way to learn mathematics that increases their engagement, understanding, and achievement. It helps to make math more meaningful and memorable. The application which has potential but is limited by access due to school board infrastructure, according to one study participant.

Google Presenter: Is a web based application which allows teachers to post presentation notes and forward the slides to students. The school board has made the transition to a Google platform for all of their internal and external communications. Google provides users with the opportunity to communicate with email and a social platform called Google+. Users also have access to project software like Google Docs, Google Spreadsheet, Google Presenter, and a few others. These main three are similar to Microsoft Word, Excel, and PowerPoint respectively. Teachers have access to Google Drive where they can create and share their material with their students by setting up classroom folders and sharing the links with their classes.

Interactive simulations and virtual labs: These include the PhEt simulations on the University of Colorado Boulder's website (<https://phet.colorado.edu>). They are powerful aids for Science and Math teachers. Virtual labs are phenomenal for giving students near real life experiences.

Gizmos & explorelearning.com are online simulations focused on inquiry learning and understanding. This website supports math and science teachers from grades 3-12 with access to over 400 curriculum standard simulations. GoogleSimulations ie ripple tank simulator is an example of an online simulation on the PhEt site. Students can test hypothesis between one or two point sources; effects related to the changing of distance of the sources to the screen; difference between light rays, water waves, and electron wave (relating to Quantum physics).

Internet: Is a network of information systems which provide plethora of opportunity for learning as well as on line communication and self-expression. Teacher's typically use the Internet for a) providing lesson content b) utilizing sites as instructional guides to teach "how to's". Popular sites include: <http://www.golabz.eu> which connects with the Phet.edu simulations and other resources and <http://www.discoveryeducation.ca/Canada/> to aid teachers in lesson content. The Internet has many different uses for teachers, and students. One of the participants has moved his teaching style into the digital world. His paperless classroom is strictly online (when technology cooperates, that is). The Internet allows him to access simulations, videos, and relevant supporting materials as well as use his Google drive to share his lessons, collect assignments from students, provide feedback, and to communicate with his classes outside of school. Another participant admitted to signing all of his students up for emails when the Internet first became available. He shares that once upon a time when Google and other search engines did not exist, one could email a question to the world-wide-web and it would 'magically' email back an answer. We have come a long way from this "primitive" usage of the Internet.

ManageBac: <http://managebac.com> is an online calendar and messaging management tool. One participant utilizes the ManageBac online software system. This system is an integrated

information system for International Education. It provides tools for efficient curriculum planning, assessment, and reporting on students in the International Baccalaureate program at her school. This system also eliminates paperwork while enhancing communication to parents and students. It can be utilized so parents can see what assignments are coming up etc.

PowerPoint: is a lecture design application that enables the presenter (teacher or student) to develop a format for a topic of interest (including intro, bullet points, video clips, etc.).

Presenters usually speak publically and lectures are well organized and concise.

Programs (Google Doc, Markbook, EBGrade, Schoology): Google Doc is an online writing program like Word/Word Perfect that allows students to save their work online into their Google account (all they need is a google email address *@gmail.com* and they can pick-up their work where left off at school once they are home). Markbook is a grading software program for teachers to track grades, assessments, attendance, etc. This program has been recently replaced in this school board with another program, EBGrade which is also grade tracking software.

Schoology is an online social platform (similar to Facebook) designed for teacher and student interaction. I used this platform while teaching a night school course last year. I added my PowerPoint presentations, videos, links, etc. which I thought would support student learning.

Students were able to email me direct through this site, ask questions to other students, submit assignments, and completing group work.

Smartboard: A Smartboard is an interactive whiteboard that uses touch detection for user input. For example, one can move the page or underline words. Smartboards are developed by Smart Technologies. This product is focused on interactive and collaborative learning between teachers and students. Users are provided with a community of like-minded users, lesson plans,

opportunity to share resources, and training and professional development opportunities. When used as intended, teachers can run simulations in real-time to their students. For example, the Smartboard comes with a number of interactive activities pre-installed for different subjects. For a science example, biology teachers can take their students through a virtual dissection of a frog all done on their Smartboard.

Socrative.com: <http://socrative.com> allows teachers to engage and assess their students learning as it happens. Similar to the use of clickers, Socrative is an online platform where teachers can set up questions and students log in using their mobile devices to answer questions. This program provides real-time questioning, result aggregation, and visualizations of individual student learning.

Storyboards: A storyboard is a graphic organizer in the form of illustrations or images displayed in sequence for the purpose of pre-visualizing a motion picture, animation, motion graphic or interactive media sequence. The storyboarding process, in the form it is known today, was developed at Walt Disney Productions during the early 1930s, after several years of similar processes being in use at Walt Disney and other animation studios (Wikipedia definition).

One participant in this study used his Smartboard to run physics simulations from the university of Colorado, PhEt simulations, in real-time with his students. Students were able to interact with the simulations directly on the Smartboard.

Videos (VHS and DVD and Internet): These are useful as short demonstrative examples and can also be used for entire lesson content. Students tend to like real-life examples that they can see, and they like to be entertained. Although VHS and DVD videos are being replaced by digital

formations available on the Internet, many schools still have usable and curriculum appropriate material available (even if the clothing looks funny to today's students (i.e. video series made in the 1980s)). Documentaries and videos series like Bill Nye the Science Guy still have valuable information for student learning. One teacher has given his students the task to convert his collection of VHS/DVD resources to digital format allowing him to upload and share the clips and videos on his online learning platforms.

Appendix F: Students Perceptions and Use of Technology

Research on students' perceptions and use of technology focuses on the shifts in learning with students becoming more actively engaged in their learning through the use of technology tools. Studies extrapolate on the volume of students who use technology as part of their day-to-day (minute-to-minute) existence and the effortlessness by which they consume and are motivated by technology. Studies focus on the importance for teachers and their institutions to keep active pace with their students' nature inclinations.

Pelgrum (2001) noticed a shift in the worldwide educational focus. His research identified the learner as making a shift from a passive consumer of educational offerings to an active knowledge gatherer and a productive participant in education activities (pg. 163).

To today's students, technology has always been commonplace and is often taken for granted because it has always been available to them (Martinez & Prensky, 2011). With "98 percent of 9th – 12th graders and even 43 percent of 2nd – 5th graders owning cell phones" (Kolb, 2011, p. 40), it is no wonder educators and parents are finding it difficult to engage and interact with the youth of today. Today's students come to school with the knowledge, understanding, and capability of using new technology with more ease than their teachers, and in ways their teachers could only imagine. They are genuinely interested in new technology and excited by its many applications and uses (de Bakker, 2007). Students may spend hours interacting with technology at home whether it be with a computer, television, iPad, tablet, mp3, or even their mobile phones; therefore, why shouldn't we engage them through their favorite technologies at school? Students are not only interacting and connecting with other students in the classroom, they now have the opportunity to connect with other students from around the world with whom

they share common interests.

Many studies focus on the student's perception of technology through a focus on their motivations and attitudes towards using technology in and out of the classroom (Ito, 2008; Brito, 2011; Lenhart et al., 2012; Squire & Dikkers, 2012). Current mobile technology is portable, convenient, and easy to access anywhere and anytime (Roschelle, 2002; Cochrane, 2008; Cheung & Hew, 2009; Squire, 2009; Hlodan, 2010; Andrews, Tynan & James, 2011). Students have the freedom, autonomy, and power to individualize their devices and to be socially interactive when using technology (Ito, 2008; Squire & Dikkers, 2012).

Interestingly, Norris (2010) reported that 23% of children in nursery school use the Internet. This number rises to 50% by grade 3 and to 79% in grades 9-12. Mobile devices provide students with infinite possibilities, means, and platforms for self-expression, collaboration, and communication anytime and from anywhere around the globe. Using mobile devices in the classroom allows the teacher to take on a supportive role while students access hundreds if not thousands of applications and reference materials. When used outside of the classroom, mobile devices can continue the communication between teacher and student and the lessons of the day while on the bus, in the car, or even at the dinner table. Teachers and students can access and provide supportive and instant feedback in and out of school 24 hours a day, seven days a week, if they have the time. With statistics like these increasing exponentially year after year, it is important for administrators to understand how their teachers perceive the usefulness and ease of use of technology before attempting to force the integration of technology on a community of educators who are hesitant to fully integrate it. This supports research by Li (2007) which found that the beliefs and views of the two influential stakeholders involved, the teacher and the students, are the most important factors for the success of any attempt to integrate technology in

the classroom, despite the intentions or goals of the collective administration.

In conclusion, students are natural adaptors to innovation and exploration. They have the means to use technology and their technologically focused motivations and savvy should behoove teachers to proactively use technology within the classroom.

Mobile devices allow science teachers to connect science content and to develop literacy skills through blogging applications and writing exercises; as well, teachers can connect with global experts in their field through Skype video conferencing and social media applications like Twitter, Facebook, and LinkedIn in the classroom from their iPads or other mobile devices (Butler, 2000; Swenson, Young, McGrail, Rozema, & Whitin, 2006; Squire, 2009). Educational programs will continue to increase their infusion with technology as society moves forward.

A focus on understanding students' perceptions of technology usage and how technology can be utilized in the classroom for the benefits of the student has been cited by a number of researchers (Vedantham & Breeden 1995; Roschelle 2002; de Bakker 2007; Li, 2007; Cochrone, 2008; Ito 2008; Squire, 2008; Atkinson & Newton, 2010; Diamantes 2010; Hlodan, 2010; van den Beemt, 2010; Humble-Thaden 2011; Thomas 2011; van den Beemt, 2011; Brito, 2011; Kolb,-2011; Charles 2012; Kiger 2012; Lenhart et al., 2012; Squire & Dikkers 2012).