"TPACK: TECHNOLOGY INTEGRATION AND TEACHER PERCEPTIONS"

by

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ABSTRACT

"TPACK: TECHNOLOGY INTEGRATION AND TEACHER PERCEPTIONS"

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As one considers the impact that technology has had on society as a whole, one might also question these changes as they pertain to the teaching and learning environment. The transformative nature of educational technologies has profoundly changed pedagogical thinking and looks to revolutionize our educational system, but are teachers really utilizing these technologies to their full potential? The TPACK framework considers three distinct areas in a teacher's ability to integrate technology and improve the effectiveness of their instruction: content, the information that is to be taught; pedagogy, the way in which the content is to be taught; and the technological, the digital tool or vehicle with which the pedagogical methodology will be delivered.

This study examined the ways ten teachers utilize technology in their lesson planning and classroom activities for variety and frequency. Additionally, comparisons were made between years of experience, with consideration of the amount of formal and informal technology training received. The purpose of this embedded mixed methods study is to inform and improve technology professional development for teachers. This study found that veteran participants displayed a reluctance to change, providing statements concerning investing time into new pedagogical practices when they consider their current practices to be sound. Novice participants, who as a group were more open to incorporating technology into pedagogical practices, needed to be afforded an opportunity to explore other emerging methods for
technology implementation. The perceptions derived from this study concerning frequency of use, and the need for more available resources, only serve to underscore the importance of improving aspects of professional development design.

The Dissertation Committee for Drexel University

Certifies that this is the approved version of the following dissertation:

"TPACK: TECHNOLOGY INTEGRATION AND TEACHER PERCEPTIONS"

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Dedication Page

My undergraduate degree was dedicated to my parents for all their hard work preparing me for post-secondary education. My first master’s degree was dedicated to my son Michael Daniel, for he was the reason for advancing my career. My second master’s degree was dedicated to my family and friends for all the support that they provided me. This degree is dedicated to me. I can finally rest knowing that I have proven myself to achieve the highest degree possible for the education discipline.
I wish to acknowledge several people who have journeyed with me on my path to a doctoral degree. First and foremost, Dr. Valerie Klein who regularly inspired me to push forward and question things that I would take for granted. Her persistent patience with my diminished writing skills has helped me to grow as a writer and as a person. Her guidance, encouragement, and wisdom put me on a clear path to my doctoral defense, while still helping me to balance life’s little interferences. I appreciate her faith in my abilities, which sometimes I didn’t believe that I had. I cannot thank her enough and would consider her a lifelong friend.

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Chapter 1: Introduction to the Research

Introduction to the Problem

Technology’s impact on the teaching and learning environment has changed not only the way our students process new concepts and achieve learning objectives, but it has also modified the way in which instruction is delivered. Students needs are diverse, and the forms of technology that they encounter in their learning environment may not fit those needs of every student or subject (Halverson, 2003). The educational technologies that a teacher may use in the teaching and learning environment may not adapt to every diverse need; rather, it is the job of the teacher to creatively apply these tools to meet the needs of the student. According to Okojie, Olinzock, & Okojie-Boulder (2006) technology in education is not a mere object to be introduced into learning activities without first considering the basic principles of learning and having a well-developed pedagogical methodology” (p. 68). How a teacher chooses to use technology in the classroom is dependent upon that teacher's expectations in each grade level, subject and class as well as past experiences and training. Examining different applications of technology in the classroom specifically how a teacher adapts the technology to best fit the lesson – may also reveal the way a teacher perceives technology.

Statement of the Problem to Be Researched

This study will examine the ways teachers utilize technology in their lesson planning and classroom activities for variety and frequency. In addition, it will look to make comparisons between years of teaching experience, with consideration of the amount of formal and informal technology training received. These variables may or may not directly impact the extent and depth of technology integration but could provide some context to the improvement of technology based professional development for teachers. The research presented in this study
will take into account a teacher's intended use of technology, a self-reported account of the classroom activity outcome, and utilize the Technological, Pedagogical and Content Knowledge (TPACK) framework as a foundational lens through which to identify patterns in technology integration by participating teachers.

**Purpose and Significance of the Problem**

**Purpose Statement**

The purpose of this study is to examine the ways teachers in a small urban school are integrating technology into their classrooms and to identify characteristics and patterns exhibited by those teachers in order to inform and improve training. The choices that teachers make in considering technology integration for educational activities may be influenced by a variety of different factors, some of which may in fact be barriers. By examining these different factors of technology use and the perceptions of them, one will begin to distinguish between considerations that improve instruction and ones that hinder (barriers). This study will also consider how a teacher adapts and incorporates technology, further highlighting technology perceptions. It is the intent to learn from these individuals and their ideas to enhance the integration of technology for the school as a whole. To fulfill this purpose, an embedded mixed methods approach will be implemented, consisting of archival lesson plan analysis, an open-ended survey, and the TPACK questionnaire with appropriate coding and analysis of each.

When examining the integration of technological devices in a variety of different teaching and learning environments, one should consider the complex environment that a classroom represents. Cuban, Kirkpatrick and Peck (2001) define a low degree of technological integration as students' use of only basic applications, such as the internet or Google to conduct a simple search or obtain images. In contrast, the development of multi-media presentations
containing animation, video editing, and completing projects that involve collecting and explaining data represent a high degree of integration. For true technology integration (examined in greater detail in chapter 2 page 38), one needs to consider technology as something beyond a tool that can be immediately integrated into the classroom. Instead, the pedagogical affordances and constraints must be taken into consideration when planning lessons that include integration of technology.

The innovation and integration of technology can provide students with the opportunity to demonstrate ideas in a format that is unobtainable in the standard classroom setting (Okojie et al., 2006). Teachers, however, may not always take advantage of the potential offered by particular technologies due to lack of training or lack of awareness. The way technology is integrated into classroom activity, curriculum and setting is key to unlocking its potential in these complex environments. As students and teachers increase their exposure to a variety of devices and software, choices and understanding regarding pedagogical application and innovation will also increase.

**Significance of the Problem**

Teachers face a variety of different factors or barriers when attempting to integrate technology into their courses. These may include the "improper operation of computers, maintenance problems associated with outdated software at home or work and inadequate technical support at work." (Javeri & Chen, 2006, p. 157). Researchers have found that educators may have a multitude of limitations, including training (Fletcher, 2006), time to learn the operation of a technology (Butler & Sellbom, 2002), time to incorporate technology into their courses, reliability (Butler & Sellbom, 2002), and technology support and access (Fletcher, 2006).
Teachers in the 21st century must not only be familiar with the operation of instructional technologies but also with their application within the curriculum and their classroom (Eisenberg & Johnson, 1996). Topper (2004) suggests that "for teachers to use technology in support of their teaching, and see it as a pedagogically useful tool, they must be confident and competent with the technology they are planning to use" (p. 304). As the successful use of technology continues to gain attention and becomes more ubiquitous in our society novice and veteran teachers may possess the pedagogy but lack a technological base from which to adapt the device (Greenhow, Dexter & Hughes, 2008). Many teachers, particularly more veteran teachers, would not have addressed technology integration in their initial teacher training and may or may not have attended professional development courses on the topic or on specific technologies. Teacher training concerning technology is critical. As part of this study participants will be asked survey questions pertaining to their technology training, both formal and informal. The results of these questions will help to identify the extent of technology training and years of teaching experience.

Having a variety of different technology tools at one’s disposal is only half the picture, what one dose with them is the other. Innovation is a very complex topic when it is applied to the teaching and learning environment. Some consider a successful “innovation” to be a new approach that brings an improved result. The way a teacher combines existing technology tools to generate a new learning experience for the students is what will change traditional pedagogical practices. In describing what innovation may look like in the teaching and learning environment, it may be helpful to first depict what are thought of as more “traditional” practices.

Traditional approaches to teaching are often characterized as involving “direct instruction:” teachers communicate content in a clear and structured way and demonstrate those concepts through explanations. Innovative approaches are much more difficult to isolate due to
the variety of different technology tools used in different situations. Innovation in one classroom can look completely different in another. The idea of innovative practices is the creation of new approaches to problems utilizing existing technologies in a different way. An example of this could be flipped learning or computer-assisted instruction. Computer-assisted instruction allows teachers to spend more time with individual students who are having difficulties while allowing others to work on a concept at their own pace. Programs such as Achieve 3000, Edginuity and Khan Academy are only a few examples of this type of innovative practice. Computer-assisted instruction improves classroom efficiency and allows for a greater amount of one-on-one attention in larger classrooms.

Examining the variations in how and when technology is utilized in classroom activities may shed some light into the pedagogical nature of the classroom teacher and his or her views on the innovation and integration of technology. This study aims to explore how we can better understand the current impacts that specific and general barriers to use of technology have on technology integration in the classroom. This study will also explore the ways teachers think about incorporating technology into their lessons on a day to day basis. With the thoughtful implementation that technology can enhance the teachers’ learning environment and student academic growth.

The TPACK framework is a conceptual model designed to rethink how a teacher might approach the integration of technology. Similar to the recommendations by Greenhow, Dexter and Hughes (2008), the TPACK framework helps the teacher to connect what is being taught to the way in which it is taught, with the technology used to enhance these connections. TPACK emphasizes "the connections among technologies, curriculum content, and specific pedagogical approaches, demonstrating a teachers' understanding of technology, pedagogy, and content that
can interact with one another to produce effective discipline-based teaching with educational technologies" (Koehler & Mishra, 2008, p.1025). By considering the impact that technology could have on the content and its delivery, a teacher might be able to overcome different factors faced and embrace new approaches to academic success.

Throughout this study the TPACK framework will be referenced in two distinct contexts, theoretical and score. The theoretical "framework" considers the ideas and concepts of the TPACK model. This theoretical-framework includes the interactions between pedagogical technical knowledge (PTK) and technical content knowledge (TCK). The TPACK "score" refers to the numerical value obtained from the TPACK questionnaire that was designed to measure the level of understanding of the TPACK framework concepts exhibited by the participating teacher. The questionnaire will provide a quantitative "score" or value related to a qualitative "framework" from which comparisons can be made.

**Research Questions**

Within this study, the researcher will look to answer the following research questions:

1. What patterns can be seen in the ways teachers adapt technologies to their current teaching and learning environment?

2. What relationship exists between a teacher's TPACK score and their perceived use of technology in their current teaching and learning environment?

3. How can one characterize teachers' decisions about technology use when viewed through the TPACK framework?

School districts across the United States are spending significant portions of their limited budgets on new technologies. These technologies hold great potential for student learning and academic growth, but how the technology is utilized may raise questions regarding the
effectiveness of the technology in a teaching and learning environment (Ringstaff & Kelley, 2002). In addition, questions often exist about an instructor’s ability to utilize the technology effectively to support students’ academic growth. This study will examine teachers’ perceptions of technology, relate those perceptions to decisions concerning the use of technology in their educational activities.

**The Conceptual Framework**

**Researcher Stances and Experiential Base**

This study will utilize the Technological Pedagogical Content Knowledge (TPACK) framework as the fundamental lens through which measurements and comparisons will be made. Figure 1 below will help to illustrate this concept.

![Figure 1](http://tpack.org)

*Figure 1: This image was reproduced with permission of the publisher, © 2012 by tpack.org from http://tpack.org.*

As seen above in Figure 1, the overlaps--Technological Pedagogical Knowledge (TPK), Technological Content Knowledge (TCK), and Pedagogical Content Knowledge (PCK)-- of the
three circles Pedagogical Knowledge (PK), Technological Knowledge (TK), and Content Knowledge (CK) represent the three aspects of the TPACK framework, which combine to form a central core of understanding known as TPACK. This core can provide a context for framing an approach to the integration of technology. The TPACK core combines all three aspects of the TPACK framework to help develop an understanding for teachers to re-focus why a technology is being utilized.

**Conceptual Framework**

Koehler and Mishra (2008; 2006) have suggested that there are three distinct skills that an effective educator must possess, the first of which is the content knowledge (CK) of their respective disciplines, which allows for a depth of content in instruction (Greenhow, Dexter & Hughes, 2008; Harris & Hofer, 2011). The second skill is pedagogical knowledge (PK); pedagogical knowledge allows the instructor to deliver the content in a variety of different ways (Wright & Wilson, 2011). The third and final capability that an effective educator must possess is technological knowledge (TK). Technology has great potential to improve the effectiveness and delivery of content (Sahin, Celik, Akturk & Aydin, 2013). This technological knowledge must blend with how students are taught (TPK) and the content (TCK) that is being delivered.

This study will take the known TPACK framework and employ it in a manner that will help illuminate how the use of technology in educational classroom activities is influenced by both teachers' perceptions and barriers faced. Figure 2, found below, illustrates these ideas.
Figure 2. Conceptual Framework of the Study Part 1

There are two major elements of how a lesson is delivered: the construction of the lesson and its execution. The construction of the lesson (seen in Figure 2 above) contains many factors, such as what will be taught and how. Critical to lesson development is the teachers' Content Knowledge, Pedagogical Knowledge, and Pedagogical Content Knowledge. Aside from these critical pieces, this study will focus on both how a teacher integrates technology into the lesson and how they perceive its use. A teacher must utilize their Pedagogical Content Knowledge to deliver the content as well as the Technological Knowledge to apply a new technology to enhance the desired learning outcome. This awareness of different technologies (Technological Knowledge) can be enhanced either through personal exploration such as
websites, blogs, iTunes Apps Store, etc. or through formal venues like professional development and conferences.

**Figure 3. Conceptual Framework of the Study Part 2**

The execution of a lesson (Figure 3 seen above) can be seen as both the application and utilization of a new technology. This is where a teacher will put into practice their vision of a technologically enhanced lesson. Factors such as his or her own personal experience with technology and their perceptions concerning student benefit also play a role in how the lesson is executed.

The application of a new technology can be considered the "trial period" for this new technology or web tool. One might ask themselves, how are students responding to its application? Did the students obtain the desired learning outcome? Did the new technology
enhance my pedagogical objective? Was it innovative? However, this time spent in application is dependent upon the availability of resources. According to Ertmer (1999) the availability of a resource is considered a first-order barrier. Ertmer identifies these barriers as being extrinsic to the educator and may include such problems as; a "lack of access to program software and desktop access" (p. 63). The way a teacher perceives how technology can impact their educational activity and the learning environment as a whole is critical to this study.

Technology utilization refers to the repetitive use of technology in the classroom. As mentioned before, teachers alike know that the application of a technology may have worked in one class but could have devastating effects in another. Attempting to apply a new technology in one class period, grade or subject is not enough of a sample to determine if a new technology is worth retaining. The utilization of technology has an inherent comfort level that must also be taken into account. Technology utilization is also dependent upon the availability of support. The availability of technical support is considered a second-order barrier according to Mistler-Jackson & Songer (2000) and Fletcher (2006). These researchers identified these barriers as being intrinsic to the educator and include technical support as one. Greenhow, Dexter & Hughes (2008) spoke of the added demands that technology integration places on teachers, these added demands could be suppressed through the establishment of an adequate support system. Frustrations arise during application if unforeseen problems occur. These frustrations may spill over into its utilization resulting in a reluctance to attempt future applications.

Figure 4 illustrates the connection between lesson plan construction and execution. Both of these processes are very complex and include a multitude of different thought process and factors that contribute to their end result. For the purpose of this study: Technology Application
Benefit, Personal Perceptions of Technology, Awareness of Technologies, and Personal Technology Experience will be considered. (Figure 4 Below).

This study will utilize the TPACK questionnaire, archival lesson plans and an open-ended survey as data collection sources. The TPACK questionnaire will identify components in the construction of a lesson plan, with particular attention to Technological Knowledge (TK) (questions 1-6) and Technological Pedagogical Knowledge (TPK) (questions 34-42). The TK will be used to evaluate the participants awareness of technology and the TPK will expose perceptions concerning the benefit of a technologies application. The archival lesson plan

**Figure 4. Conceptual Framework of the Study Part 3**
analysis will help to determine frequency of use and type of technology utilized. Lesson plan analysis will help to provide an understanding of a participant’s awareness of available technologies, the application of a technology, and its utilization through the variety of and frequency of use. The open-ended survey questions will help to determine a teachers' perspective, encountered frustrations, and factors that influenced the use or disuse of a technology. This survey will also take into account personal perceptions concerning the use of technology in the teaching and learning environment, as well as personal experiences with technology. The (figure 5) below helps to illustrate these data collection sources.

![Conceptual Framework of the Study Part 4](image-url)

*Figure 5. Conceptual Framework of the Study Part 4*
A teacher's choice to use a particular piece of technology and adapt it to fit the desired outcomes of the educational activity is at the heart of this study. As will be discussed in more detail later in this paper how, the awareness, operation, application and utilization of technology in a lesson are, at times, met with various time barriers. For example, the availability of resources and support may also alter one's perception of student benefit versus time investment. The TPACK framework predicates itself on the construction of sound content and pedagogical methods first, then the application of a technological component at the end. This final component of the TPACK framework encounters many different "time" barriers, discussed later in Chapter 4. With one's awareness of available resources and support, some individuals may feel that the time investment in a new technology will only detract from time investments spent on other teaching and learning environment tasks.

Niess (2005) found that teachers' TPACK development process was multi-faceted, and involved them acquiring technological skills, as well as creating pedagogical ideas for technology integration. A teacher's development in the TPACK framework is rather complex and requires time to practice and perfect these skills. Kushner-Benson & Ward (2013) found that when technology knowledge is based "solely on their ability to use various technology tools, a balanced and integrated TPACK level is unlikely" (p. 153). Kushner-Benson and Ward (2013) also noted that "instructors who are able to accurately describe their understanding and application of pedagogical knowledge are more likely to exhibit TPACK integration ability" (p. 153). In line with these findings, Mishra and Koehler (2006), state:

There is no single technological solution that applies for every teacher, every course, or every view of teaching. Quality teaching requires developing a nuanced understanding of the complex relationships among technology, content, and pedagogy, and using this understanding to develop appropriate, context-specific strategies and representations (p. 1029).
The TPACK framework may not be suited as an analysis tool for every instructor or every course, but it does provide a conceptual framework from which instructors could re-evaluate how they approach their course pedagogy.

**Definition of Terms**

**Technological, Pedagogical and Content Knowledge:** Technological, Pedagogical, and Content Knowledge (TPACK) is a type of organizational framework for knowledge consisting of three major domains that support content-based technology integration. For the purpose of this study, TPACK will "emphasize the connections among technologies, curriculum content, and specific pedagogical approaches, demonstrating how teachers' understandings of technology, pedagogy, and content can interact with one another to produce effective discipline-based teaching with educational technologies" (Koehler & Mishra, 2008, p.1025).

**Content Knowledge:** For the purpose of this study, content knowledge will represent the depth of discipline specific knowledge, measured by the teacher's ability to pass a state certification exam. (Greenhow, Dexter & Hughes, 2008; Harris & Hofer, 2011).

**Pedagogical Knowledge:** This study will consider pedagogical knowledge as the frame of reference from which the instructor chooses to deliver the content knowledge in a variety of different ways. A skilled instructor will effectively choose which method of delivery is best suited for the students that they are instructing (Wright & Wilson, 2011).

**Technological Knowledge:** This study will consider technological knowledge, not only referring to the use of a computer, server, or network, but it also refers to the technical equipment used in one’s profession of study. This knowledge will come to mean the correct operation of computers, tablets, video recording devices, projectors, speakers, and other electronic devices that aid in the processing of information (Sahin, et al., 2013).
**Technological Pedagogical Knowledge:** This study will consider this type of knowledge as the ability to determine which technology would best fit the method of instruction. Possessing this type of knowledge will allow for the proper choice of technology to coincide with the selected instructional technique (Mishra & Koehler, 2006).

**Technological Content Knowledge:** This aspect shall be defined as the knowledge of technologies relative to specific content. For example, a science teacher would need to know how to operate a microscope or a centrifuge, while a math teacher would require the technical operation of a graphing calculator, protractor, or compass. The science or math teacher would possess the technical knowledge to operate a complex technology specific to their discipline (Mishra & Koehler, 2006).

**Teaching and Learning Environment:** This term refers to the environment in which instruction and the learning process come together to aid in student academic growth and understanding. For the purpose of this study, the teaching and learning environment will consist of the classroom environment from which a specific course is assigned to deliver instructional content.

**Innovation:** This study will consider innovation as the application of existing technologies to introduce, produce and develop new ideas and concepts through content-based or project-based approaches. (Kuboni et al., 2016)

**Technology Integration:** This study will consider true technology integration is only achieved when students are able to select technology tools that will help them obtain information, analyze it and synthesize that information for future use (NCES, 2008).

**Veteran Teacher:** For the purposes of this study a veteran teacher will be defined as an educator with no less than nine years of teaching experience, who holds a tenured status within the district, and who possesses or is working on a Master’s Degree.
Novice Teacher: For this study a novice educator will be defined as one with less than eight years of teaching experience who does not hold a tenured position, and who is not working on or does not possess a Master’s Degree.

Assumptions, Limitations and Delimitations:

Assumptions

This researcher will assume that the participants in this study will answer the provided questionnaire and survey honestly and without prejudice in both sampling occurrences. There are also assumptions that the participants will not alter their frequency of technology use for the duration of this study. It may also be assumed that the participants accurately document their technology use in their respective lesson plans. This researcher also believes that an increase in usage frequency and variety will help to dissolve the second-order barriers seen in the research of Ertmer (1999) and Javeri & Chen (2006), allowing participants to become less intimidated by technology. It may also be assumed that the participants of this current study have sufficient access to technology-based devices, are operating within an infrastructure that can support the use of such devices, and that the participants utilize these devices on a regular basis.

Limitations

This study will be limited to one school district, classified as an urban educational setting, in the southeastern region of the state of Pennsylvania. This study will also be limited to full-time participants in one of the main subject areas: Math, Science, English, and Social Studies. Each of the studied participants will be limited to operating under a discipline-specific certification, issued by the state of Pennsylvania, and not under any form of emergency certification or its equivalent. This study will be limited to the consideration of a participant’s
years of experience and subject taught. This study will not consider participants who teach a foreign language, music, or provide a special service to the school such as counselor or nurse.

**Delimitations**

One of the delimitations of this study will consist of the feelings of the participant when completing open-ended survey questions and their interpretation of the intended answers. The feelings of the participants and their fear of punitive actions may prompt them to respond in a manner that is uncharacteristic of their daily use of technology. This uncharacteristic reporting of technology may influence their score on the questionnaire sampling data. Additionally, the participant's interpretation of how technology will be integrated into the lesson might also be examined. The participants’ perceptions of effective use of technology may vary from lesson to lesson, and both the open-ended survey and questionnaire responses may hinder some creative initiatives sought by teachers.

Finally, this study considers the discipline order, class period, grade level, day of the week, assessment sequence, and unexpected interruptions as participants determine the technology being used, frequency of use, and perceptions of appropriate use. The order, date, time, and class period that they choose will be under their control for authentic data collection.

**Summary**

The transformative nature of educational technologies has profoundly changed pedagogical thinking and looks to revolutionize our educational system. In order to support such broad change, we must also understand not only how to support instructors in utilizing these technologies to their full potential but also the factors that may impact limited use and ways to mitigate them.
Incorporating technology into the classroom is a complicated task. There are a multitude of barriers that can prevent technology integration from happening. Understanding the existing technologies and potential barriers, as well as how teachers experience those barriers, is critical to successful integration and adaptation over time. The TPACK framework offers a lens into the integration of technology in classrooms. Use of this framework, along with analysis of lesson plans and open-ended surveys, will inform this study to examine the range of ways that teachers implement technology and experience barriers. Further, this study will look to explore patterns in these experiences along dimensions of teachers’ years of experience, subject area and other emergent relevant characteristics.
Chapter 2: The Literature Review

Introduction to Chapter 2

Teachers in the 21st century must not only be accomplished in instructional techniques and the operation of technology, but also in the integration of new technologies into both curriculum and classroom practice (Eisenberg & Johnson, 1996). The traditional lecture-style of learning is quickly becoming obsolete and classrooms are often hives of activity, exploration, application, discussion, and reflection (Catchan, 2013). Twenty-first century learners are accustomed to efficiently and effectively accessing content knowledge that is meaningful, adaptable, and innovative, yet access to different technologies in both the school and classroom are still insufficient. These learners must also develop collaborative and communicative skills, cultural sensitivity, and a sense of global awareness (Gardner, 2012). In order for educators to foster this learning, they must consider what technologies are being used by students, and how they can be leveraged in the classroom to enhance school-based learning opportunities.

The purpose of this study is to understand the range of ways in which the teacher participants innovate and incorporate technology into their teaching and learning environment. To that end, the study compares teachers' technology use across categories such as years of experience teaching, while examining teachers’ perceptions of their level of technology integration. The results are intended to add to the current understandings of how educators utilize technology in the classroom and how this, in turn, informs the kinds of support--both individual and school-wide--that are necessary to improve innovation and integration of technology in classrooms and schools. This study employs an embedded mixed methods approach consisting of the examination of archival lesson plans, an open-ended survey, and the TPACK questionnaire, with appropriate coding and analysis of each.
In examining the existing literature on the use of technology in the classroom, the following three streams of research emerged as relevant and include:

- the definition of technology integration and the perceived use of technology;
- barriers teachers face when integrating technology; and
- the TPACK framework as a lens for understanding how to support teachers' efforts to integrate technology successfully in the teaching and learning environment.

**Literature Review**

**Stream #1: What is technology integration?**

Technology integration in the teaching and learning environment is continuing to evolve and becoming more important as education moves further into the twenty-first century. The ways in which teachers accomplish this integration are as diverse as the types of learning styles that students exhibit in any classroom. Digital devices and supporting equipment, such as computers, tablets, smartphones etc. can afford opportunities to enhance the learning experience and convey concepts and ideas that would otherwise be difficult to express. Defining what technology integration is, and what it is not, should be the first step in deciding how to incorporate it into the classroom (Dockstader, 1999), and a clear definition of technology integration supports analysis in this study.

Defining technology integration is complicated and researchers have assumed multiple perspectives on this subject. In the past 30 years, the definition of technology integration has developed and been refined by various authors and researchers. The “uses” presented by Thayer (2011) are a thoughtful lens for examining this development and will help to support this researcher to develop a definition of technology integration for this study.
According to his blog Education4site, Thayer (2011) describes three uses of technology integration and argues that without considering each of the three one might miss the holistic intent and thus will have a limited picture and understanding of technology integration. The three “distinctly different aspects” are: Technology Integration in Learning (TiL), Technology Integration in the Classroom (TiC), and Technology Integration in Instructors’ duties (TiI). Each of these aspects can be considered as a piece of technology integration as a whole in a teaching and learning environment. However, for the purposes of this study, these different perspectives, collectively, will be considered as technology integration.

To some teachers, technology integration might mean utilization of the most-recently developed technologies such as: tablets and wearable devices; implementing a one-to-one laptop initiative, where each student is provided with a laptop; development of daily lessons integrating an interactive whiteboard; or even the launch of online instructional programs that may substitute for the traditional textbook. To other teachers it may mean creating a PowerPoint to demonstrate an understanding of a concept, or it may mean taking the students to the computer lab once a week to work on a research project. Still other teachers may view technology integration as the use of the overhead, chalkboard or dry erase board, or textbooks with paper and pencil.

Technology can provide students with the opportunity to demonstrate creative ideas in an innovative format that is otherwise unobtainable in the standard classroom setting (Okojie, et al., 2006). Not only must the technology be used, but choices about how to integrate it into the learning environment must be deliberate and support students by, for example, enhancing a student’s understanding and perception of the concept being presented, or enabling the student to express his or her understanding of the concept in a novel way. Teachers might also find the use
of technology appealing because it provides access to a range of alternative instruction options that exposes them to both how and what students understand.

Technology integration is not limited to the physical pieces of equipment in the classroom but must include a knowledge base from which to use it productively. Okojie, et al., (2006) conducted a study on the perceptions of technology integration and how issues of computer shortage, lack of computer skill, and technology intimidation could hinder the integration of technology in a teaching and learning environment. The researchers studied how technology integration is narrowly perceived and they focused on that perception to help establish an understanding of the scope of technology integration in education. Okojie, et al., (2006) also considered the development of learning objectives based on technology use, the selection of instructional methods to further technology integration, the solicitation of feedback from teachers, and the evaluation of assessment strategies for follow up activities.

The researchers established the argument that technology needs to be used for teaching and learning and should be considered as an integral part of instruction, not as an object exclusive to itself. By considering the how and the why of technology integration as Earle (2002) did, educators can discern connections between the two, and draw technology closer to instruction. According to Okojie et al. (2006), "Technology integration not only involves the inclusion of technical artifacts per se, but also includes theories about technology integration and the application of research findings to promote teaching and learning" (p. 66). Teachers must possess some pedagogical intent to enhance the learning experience through the use of a technological device. Okojie, et al., (2006) go on to describe this needed intent as:

Strategies for selecting the desired technologies, skill to demonstrate how the selected technologies will be used, skill to evaluate such technologies, as well as the skill to customize the use of such technological skills in a way that addresses instructional problems. (p. 66)
According to a study by Cuban et al., (2001), students' use of only applications, such as the Internet to conduct a simple search or Google to obtain images, represents a low degree of technological integration. In contrast, the development of multi-media presentations containing animation, video editing and completing projects that involve collecting and explaining data, represents a high degree of integration. Teachers who are exploring questions such as "How can one take what they already have and enhance it through the use of technology?" exhibit the type of thinking that might elevate technology integration to the next level (Cuban et al., 2001, p. 815).

While technology integration, as a phrase, is used often in educational settings, it is not clear that everyone means the same thing when they use that phrase, as seen in the above examples. Existing definitions of technology integration are explored in this section and combined to form an accepted understanding for the underpinnings of this research. According to Condie (2009), who considers the integration of technology from a business perspective, "the lack of a precise definition of technology integration has caused the term to be inappropriately associated with the most basic and limited data meshing procedures" (Condie, 2009, p. 6). This concept has also been found to be true in a great number of teaching and learning environments. True integration, Condie argues, enables the user to have a complete set of information in one system that is retrievable at the touch of a button. With a system such as this, information can be passed effortlessly between related applications to ensure that accurate and complete information is used throughout the information exchange process (Condie, 2009).

Strong technology integration may be dependent upon both the teacher's perception of its effective use, and the perceived understanding of what the students may obtain from the utilization of technology. According to Earle (2002), "Technology involves the tools with which
we deliver content and implement practices in better ways. Its focus must be on curriculum and learning. Integration is defined not by the amount or type of technology used, but by how and why it is used" (p.7). This idea of intended use was also emphasized by Okojie, et al., (2006) who state, "it should be noted that technology, which is used to facilitate learning, is part of the instructional process and not an appendage to be attached at any convenient stage during the course of instruction" (p. 66).

The integration of technology goes beyond the utilization of a digital device, but rather is a part of the instructional process and must be deliberate in how and why it is being used. For the purpose of this study, a digital device will be defined as an electronic device such as a laptop, tablet or smart phone. Simply placing these digital devices in the classroom or establishing a computer lab is only providing increased access for students. Technology integration must also consider electrical infrastructure and network capabilities to ensure adequate operation as well as teacher education to support effective classroom and pedagogical use. It is insufficient to provide students and teachers with the digital device without the support to explore what can be done with these technologies and how their use can enhance the learning process.

In 2008, the National Center for Educational Statistics (NCES) described technology integration in this way: "Effective integration of technology is achieved when students are able to select technology tools to help them obtain information in a timely manner, analyze and synthesize the information, and present it professionally." It continues to state that "the technology should become an integral part of how the classroom functions; as accessible as all other classroom tools" (NCES, 2008). This more refined definition now considers not only the perceptions of the teacher, but also includes the role of the student in accessing and using technology.
Mishra and Koehler (2009) would concur by stating, "Technology integration approaches that do not reflect disciplinary knowledge differences, the corresponding processes for developing such knowledge, and the critical role of context ultimately are of limited utility and significance, as they ignore the full complexity of the dynamic realities of teaching effectively with technology" (p. 58). The authors continue, explaining that the concept of integrating technologies into the teaching and learning environment can be seen through a variety of different lenses, and only through exploring each can one obtain a sense of what true technology integration should look like.

The definition of technology integration is complicated and hinges upon the teachers’ perception of intended use. The teacher must consider the pedagogical potential of technology to enhance the lesson, as well as student understanding in obtaining the desired learning outcomes. To begin defining integration, an acknowledgment should be made that an agreed upon a definition has yet to emerge (Dockstader, 1999, Condie, 2009). The variations identified in defining integration seem to be dependent upon one's perspective of use. As noted earlier, Thayer (2011) considered three different aspects of integration, TiL (Technology Integration in Learning), TiC (Technology Integration in the Classroom), and TiI (Technology Integration in Instructors’ duties). These device classifications begin to shape how one might perceive use from this intended use.

Cuban et al., (2001) considered different degrees of integration ranging from a simple Google search to a collaborative multi-media presentation. Researchers have identified how the integration of technology goes well beyond the act of placing digital devices in the classroom, establishing a computer lab, or providing increased access for students (CAEP, 2011, NCES, 2002). Integration of technology must also consider how and why it is used (Earle, 2002, Okojie,
et al., 2006) and consequently establishes a pedagogical basis of intent. For the purpose of this study, the following will be considered as the definition of technology integration: True technology integration is only achieved when students are able to select technology tools that will help them obtain information, analyze it and synthesize that information for future use (NCES, 2008).

It is the hope of this researcher to further explore the ways a teacher chooses which technologies to use, and for what purpose, so that individuals' definitions of integration may be further explored within one school. To inform this study, an examination of the research on the following questions was undertaken: What are the factors that influence particular technology choices for teachers? Do teachers define the affordances of particular devices and technology platforms similarly? Do those definitions vary by discipline? The choices that teachers make to incorporate technology into their teaching and learning environment seem to stem, at least in part, from their own personal knowledge base of what technology is available, what it can do, and how it can be used to enhance the learning experience through innovative practices. A better understanding of this process could inform how we think about supporting the development of technological integration for teachers and perhaps contribute to an expanding definition of what it truly means to integrate technology.

Innovation on the other hand, is what a teacher does with the integration of technology. This viewpoint focuses on what is being done with what is available to teachers. Providing teachers with the latest technology may not provide the students with a meaningful learning experience if the teacher is not utilizing the technology in meaningful and engaging ways. In a study by S. H. Kwek (2011), the researcher looked at how design thinking (innovation) was used in the teaching and learning environment as a new model of learning. Kwek utilized observations
and interviews to develop a fuller understanding of teacher’s motivations that drive one’s ability to adopt innovative approaches to instruction. “Schools whose curriculum and pedagogy fail to engage our younger generation as active learners and meaning creators are thus not doing justice to a nation’s development, especially when knowledge has become power in a globalized world” (p. 3). If teachers are not utilizing the technology available to them in meaningful ways their students are missing out on the chance to express their creativity and a chance to be innovative.

Kwek found that teachers must have a mastery of their academic core content that then drive how design thinking is used in the teaching and learning environment. “The basic instructional approach of talking to students as they sit passively in their seats” (p. 2) remains to be the most common teaching style. “Design Thinking is an approach to learning that focuses on developing children’s creative confidence through hands-on projects that focus on empathy, encouraging ideation and fostering active problem-solving skills” (p. 4). As a teacher begins to utilize design thinking they can provide experiences for students that encourage meaning without the imposition of a fixed set of knowledge and skills.

Even though times have changed, schools have kept the logic of preparing factory workers as the basis of their existence. In a study by L. Donovan, T. D. Green and C. Mason (2014) they developed an innovation configuration map based on the Concerns-Based Adaption Model of Change. The results of this study indicate that 21st century skills can be manifested in the teaching and learning environment through content-based and project-based approaches. Donovan et. al states that “Without a consistent operational definition of 21st century skills (such as innovation) it is difficult to determine whether true 21st century teaching and learning is occurring” (p. 162). They go on to state that, “The perspective that we must first have is an understanding of implementation before we can begin to determine effectiveness, it is apparent
that there is a need to clearly document what a 21st century teaching and learning environment is before we can develop an effective assessment of its impact” (p. 162).

Kuboni, Lentell, Mackintosh, Victor, Webb, and West (2016) define innovation as “the process of making changes to something established by introducing something new.” It applies to “…radical or incremental changes to products, processes or services” (p. 1). For the purpose of this study, innovation will be defined as the application of existing technologies to introduce, produce and develop new ideas and concepts through content-based or project-based approaches.

**Stream #2: What barriers do teachers face when integrating technology?**

The struggle to define technology integration is impacted by individual perceptions of what technology is, and these perceptions, in turn, may influence the way these individuals experience barriers to integration in their classrooms. Known barriers include: "improper operation of computers, maintenance problems associated with outdated software at home or work and inadequate technical support at work " (Javeri & Chen, 2006, p. 157); time to learn the operation of a technology (Butler & Sellbom, 2002); and technology support and access (Fletcher, 2006). Experiences with these operational barriers can impact willingness to engage with existing and future technologies in the classroom.

As educators begin to integrate technology into their courses, they are likely to encounter barriers that might deter them from pursuing any further integration attempts. Greenhow, et al., (2008) state that, "Skillful teaching is demanding, and integrating technology into teaching and learning places additional demands on teachers..." (p. 9).

Ertmer (1999), discusses two types of barriers that teachers face when confronted with these types of added demands. She identifies "first-order barriers” as being “extrinsic to educators and may include such problems as a lack of access to program software and desktop
access, insufficient time to develop instructional strategies, and insufficient technical and
administrative support” (Javeri & Chen, 2006, p. 156).

Ertmer (1999) also describes "second-order barriers,” which are “intrinsic to educators
and include beliefs about teaching, beliefs about computers, established classroom practices, and
an unwillingness to change" (Javeri & Chen, 2006, p. 156). In a later study, Becta (2004),
considered Ertmer's (1999) second-order barriers and whether they related to the individual
teacher (teacher-level), citing such factors as lack of time, and lack of confidence; or whether
those barriers related on an institutional level (school-level), examining issues such as lack of
effective training in solving technical problems and lack of access to resources. Becta (2004)
concluded that "Recurring faults, and the expectation of faults occurring during teaching
sessions, are likely to reduce teacher confidence and cause teachers to avoid using the
technology in future lessons" (p. 3).

Ertmer's (1999) first and second order barriers can also be viewed from the perspective of
resources and materials. Pelgrum (2001) explores these barriers as they impact both material and
non-material facets of teaching. Material conditions may include the insufficient number of
computers or copies of software. The non-material conditions may include teachers' insufficient
knowledge of available resources, ineffective professional development of technology skills, the
difficulty of integrating technology into one's own instruction, and insufficient preparation time.

The NMC 2014 Horizon Report (Johnson, Adams-Becker, Estrada, & Freeman, 2014)
suggests the need for not only students to have digital fluency, but for faculty members to have it
as well. "Digital literacy has been deemed critically important to both students and instructors in
higher education, but it is widely acknowledged that there is a lack of effective training to ensure
that faculty are getting the skills they need to guide students" (p. 22). Georgina and Hosford
(2009) and Fletcher (2006) agree that a call for more technological professional development for faculty seems to be warranted. Becta (2014) concluded that, "Any training program needs to ensure that teachers are made aware of the benefits of using technology" (p. 3).

David Georgina and Charles Hosford (2009) conducted a study of higher education faculty concerning their perceptions of technology integration and training. By administering a survey at the conclusion of a professional development workshop series on technology, they were able to examine the technology training and digital literacy of participants and study the impact that it had on their pedagogy. Georgina and Hosford (2009) found that, in terms of training,"56% of the faculty preferred small group training" (p. 693); furthermore, in terms of integration or competency, "71.2% where found to be non-proficient" (p. 695) at utilizing online web space to teach a course within their content area. Based on these survey results, the researchers concluded that technology training should be "geared toward specific goals for specific faculty" (p. 695).

Hora and Holden (2013) examined the role that instructional technologies play in teacher reform efforts. The researchers looked at three distinct areas: (a) awareness of local resources for instructional technologies, (b) decision making processes regarding technology use, and (c) actual classroom use of the technology. Interviews and classroom observations were conducted with over 40 faculty members in three different departments (math, physics, and biology) at three different universities across the U.S. The results indicated that the use of technology-based innovations was influenced by the desired learning goals for each department, perceived usefulness of the tool, and cultural conventions of the disciplines. Classroom use of the technology varied across the different disciplinary groups, with math and biology exhibiting relatively limited utilization.
Technology training can be considered from both a formal and an informal perspective. The technology training referenced in the preceding paragraphs would be considered formal training, taking place in a classroom or professional development setting. However, many technology-interested educators engage in learning about technology on their own; this is considered informal training. An emergent question for this paper is how the formal and informal learning experiences influence the implementation of technology at the classroom level.

This research study considers both the formal and informal technology training that an educator has had and uses that information to identify the individual's perceptions of the usefulness of technology in the classroom, as well as perceptions of his or her level and competency with technology integration. These perceptions of effective use of technology can also influence the use of technology in the teaching and learning environment as much as the formal technology training researched in the above studies.

The Horizon Report (2014) also notes a resistance on the part of education faculty towards the use of different technologies, with a potential negative impact. "If they are reluctant to embrace new technologies and the promotion of digital literacy, students will not see the importance of these competencies to succeed in the workforce" (Johnson, et al., 2014, p. 22).

Cope and Ward (2002) analyzed the perceptions of 15 veteran high school teachers who had little or no professional development in the use of technology in the classroom and found that these teachers were less likely to use it. These researchers state that "successful integration of learning technologies leading to enhanced learning outcomes is unlikely unless teachers perceive and use technology as an integral part of a student centered/conceptual change" (p. 3). These researchers also found that, within this cross-section of teachers, "such perceptions are unlikely to lead to the use of learning technologies in the classroom in a manner that facilitates
successful integration and enhanced learning outcomes" (p. 10). In a similar study, Royer (2002) found that the more teachers were involved in classroom technologies, the more likely those teachers were to use that technology for instruction. Could this lack of effective technology professional development (Cope & Ward, 2002), an unwillingness to embrace new technologies through integration into course work (Johnson, 2014), and the application of informal training to advance and enhance course learning objectives, as suggested by Russo et al., (2014), constitute themselves as an additional barrier, as seen in the work of Ertmer (1999)?

**The Role of School Leadership in Technology Integration**

School leadership can play a vital role in successful technology integration in classrooms and schools. School districts have a responsibility to create an environment that will provide not only sufficient access to computers and electronic networks, but also access that is significant enough to support the kinds of use that could make a notable difference in the classroom. According to Fullan (2001), an effective school leader should possess characteristics such as an understanding of change, openness to innovation and a willingness to encourage learning and teaching. Administrators should expect teachers and students to use technology in their teaching and learning activities, and as leaders in innovation, administrators should also embrace technology and make use of it themselves as part of their school's investment in technology.

Fullan (2011) defined the term “simplicity” to describe a simple yet complicated task. This concept lends itself to the notion of technology integration in schools. As an effective director of technology, one would understand the complexity of making a digital purchase (purchasing of digital devices), with the purpose of transforming the teaching and learning environment. The director of technology should attempt to simplify a complicated decision by
considering the needs of the users and their ability to be effective with the digital devices that
they are provided.

Recently, the school district for the study site purchased new laptops for their teaching
staff. Each staff member received a new 2016 MacBook Pro with Retina Display, which was at
the time latest laptop produced by Apple. The administrative decision makers intended to
provide their teachers with the most up-to-date technology in order to give them the tools that
they would need to better integrate technology into their daily instruction. This line of thinking
would seem to make sense. If teachers are expected to instruct students in this digital age, then
schools must supply the teachers with the appropriate tools to do so. The problem with this line
of thinking lies in the design of the laptop. The MacBook Pro's that the teaching staff received
lack a CD-ROM drive. The problem with the lack of a CD-ROM drive is that most of the
curriculum materials for the different disciplines are found on a CD. With no CD-ROM drive,
teachers are restricted from utilizing the curriculum materials, showing historical videos,
assigning listening activities in Music or a Foreign Language class, and installing supplemental
software that could further enhance the students’ learning experience. Thus, the school district
has introduced a barrier that was not there before.

Choosing to use technology as part of a classroom learning activity or vehicle from which
to facilitate the learning process may on the surface seem like a rather simple task. But, as we
have seen, other variables such as technology training, perceptions derived from these formal
and informal learning experiences, lack of access to digital devices, lack of technological
support, and the time necessary for one to fully understand the operations of a digital device and
its application in an existing curriculum are much more complex. As we have seen in the above
example, the "simplicity" that Fullan (2011) speaks of has direct implications on the choices that teachers and administrators make when attempting to integrate technology into their classrooms.

Carkir (2012) states that computer teachers and technology integration specialists have an equally important role in integrating new developments into the educational environment, whereas administrators are responsible for prioritizing the use of new technologies in schools and ensuring that computer teachers are provided with the support that they require. Carkir’s study showed that "today, educational leaders are making the necessary investments to ensure that technology is integrated into the teaching-learning process" (p. 121). At this point, it is a well-known fact that technology integration is a costly, ongoing expense. Funding of technology is not a one-time or one-budget-year expense, it’s a recurrent investment on multiple levels that not all school districts can afford. In some cases, external sources of funding might be necessary to maintain not only meaningful technology integration but also functional technology-infused learning environments.

The benefit of incorporating technology into classrooms depends on teachers' meaningful integration to support learning objectives in new or varied ways. Savoy, Proctor, and G Salvendy (2009), point to the debate over the educational value of technology and highlight the need for a systematic evaluation concerning how well technology achieves the goal of improving learning. In order to integrate computers into instruction, teachers must have access to technology. This access can only come from the actions and financial decisions of school leaders. Unfortunately, many teachers find hardware and software availability are limited in their schools. The cost of upgrades, support, and training, hardware and software are often not considered in school planning.
The difficulties associated with technology integration are often attributed to the nature of existing curricula and instructional practices (Edelson, 2001), lack of robust technological infrastructures and support (Mistler-Jackson & Songer, 2000), and teacher abilities and skills (Chisholm & Wetzel, 2001). Educational leaders and teachers need to factor in an understanding of the context within which the technology being adopted for classroom use was originally developed and the expertise associated with its implementation. Furthermore, they must consider the complex processes associated with the adoption, adaptation, and implementation of the technology as it is moved from everyday application to the context of a teaching and learning environment.

Today’s teachers face a difficult challenge to adequately address an ever-increasing range of student needs. Perhaps now more than ever, there exists a need for educators to productively incorporate technology as an alternative method to enhance instruction. Teachers continually strive to acquire tools in order to empower students to accept new roles in their own learning and to expand their possibilities for collaboration and construction of knowledge; consequently, technology tools have added a new twist to the traditionalist way of instruction delivery, by providing many new opportunities for educators (Johnson, 2000). The impact of this study should provide some insight into teachers' perceptions of technology use, the perceived impact that the technology will have on the lesson and what if any, correlation can be made between these perceptions and TPACK scores.

Stream #3: How does the TPACK framework apply to the integration of technology?

The complexity of general educational practice and specific classroom instruction is not adequately captured by focusing solely on how teachers use particular pedagogical techniques or digital tools (Halverson, 2003). Wright and Wilson (2011) studied ten teacher perceptions of
technology use and integration in their classrooms--five years after completing a teacher education program--which focused on technology use in the teaching and learning environment. The researchers based their work on Hooper and Rieber's (1999) five phases of technology use (familiarization, utilization, integration, reorientation, and evolution) to categorize their work and used it as a scale for technology engagement in the classroom.

The following table defines the categories, as based on the work of Hooper and Rieber (1999) with direct quotes from Wright and Wilson (2011, p.49):

Table 1

Categories based on the work of Hooper and Rieber (1999)

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
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<tbody>
<tr>
<td>Familiarization</td>
<td>&quot;learning the 'how-to’s” of using technology&quot;</td>
</tr>
<tr>
<td>Utilization</td>
<td>&quot;trying the technology, but will not miss it if taken away&quot;</td>
</tr>
<tr>
<td>Integration</td>
<td>&quot;using technology for certain tasks; designated uses&quot;</td>
</tr>
<tr>
<td>Reorientation</td>
<td>&quot;using technology for more than delivery of content; focus is more on student learning&quot;</td>
</tr>
<tr>
<td>Evolution</td>
<td>&quot;continuing to evolve, adapting and integrating technology&quot;</td>
</tr>
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Wright & Wilson (2011) found that teachers who were performing at the top levels of Hopper and Rieber's scale--reorientation and evolution--had received additional technology-specific professional development, utilized the available technology in their schools and obtained additional support from their school-based community.

Smolin and Lawless (2011) considered the integration of technology as a result of ongoing professional development practices. Smolin and Lawless evaluated the ineffectiveness of technology integration professional development and discuss three specific collaborative evaluation models; examine key issues associated with implementing them; and
analyze how each model has the potential to strengthen and sustain professional development. The researchers found that teachers deem professional development successful only if it deepens their teaching of a particular concept, helps them create instructional conditions conducive to student engagement, and fosters student learning of content. In particular, Smolin and Lawless advocate for more careful and more systematic approaches for documenting how technology integration occurs within schools, what increases its adoption by teachers, and the long-term impacts that these investments have on teachers and students.

Given evidence that instructional technologies can be used with varying degrees of pedagogical quality, it is important to go beyond accounting for whether or not an instructional technology is being used in the classroom. As much of the technology integration literature suggests, researchers should examine how these technologies are being used and to what ends (Aagaard. 2017; Drew. 2015; Ozerbas & Erdogan, 2016; Ponners & Asim, 2016; Ruggiero, & Mong, 2015). When one considers how an educator plans for an instructional activity, it is typically conceptualized around content goals and organized according to learning activities. The application of a technology (integration) should be done so with the intent of enhancing the learning experience through innovative practices.

Technological, Pedagogical, and Content Knowledge (TPACK) is an organizational framework consisting of three major domains that support technology integration (Mishra & Koehler, 2006; Koehler & Mishra, 2008). This framework is utilized to understand a teachers' knowledge requirements for effective technology integration. TPACK examines the connections among technologies, curriculum content, and specific pedagogical approaches, demonstrating how content areas can interact with one another to produce compelling discipline-based teaching with educational technologies. Within this framework, the three interdependent components of
knowledge--content knowledge (CK), pedagogical knowledge (PK), and technological knowledge (TK)--are all framed within and influenced by contextual knowledge.

Mishra and Koehler (2006) explain: "There is no single technological solution that applies for every teacher, every course, or every view of teaching. Quality teaching requires developing a nuanced understanding of the complex relationships among technology, content, and pedagogy, and using this understanding to develop appropriate, context-specific strategies and representations" (p. 1029).

Keatings and Evans (2001) explain that "technological pedagogical content knowledge extends beyond proficiency with technology for personal use to an understanding of how technology can be integrated with subject matter and the technology itself." The TPACK framework highlights the "connections, interactions, affordances, and constraints between and among content, pedagogy, and technology" (Mishra & Koehler, 2006, p. 1025). Topper (2005) believes that "for teachers to use technology in support of their teaching, and to see it as a pedagogically useful tool, they must be confident and competent with the technology they are planning to use" (p. 304). Koehler and Mishra (2005) "focus on a problem of practices and seek ways to use technology (and thereby learn about technology) to address the problem" (p. 95) and to understand that technology has constraints, has breakdowns, and is context sensitive.

Researchers generally agree that TPACK can serve as an appropriate framework that bridges teacher education and educational technology. What distinguishes TPACK from earlier frameworks is that it does not specify specific stages or levels of technology integration. Other models of technology integration, such as Substitution, Augmentation, Modification, and Redefinition (SAMR), employ descriptive levels to determine how a piece of technology will be used (Hilton, 2016). These levels can change from class to class or even lesson to lesson;
consequently, the SAMR model categorizes the use of a particular piece of technology, rather than the pedagogical means behind the decision for its use. TPACK focuses on the pedagogy of technology use, rather than the technology itself. Both models are effective in their own unique application; for the purposes of this study, this research will consider the TPACK framework as a conceptual lens.

Technology is not a mere object to be introduced into teaching and learning activities at will without considering basic principles of learning and sound pedagogy. The teacher should consider how the selected technology fits into the objective of the lesson, methods of instruction, evaluation, feedback and follow-up initiatives.

**Summary**

As one considers the impact that technology has had on society as a whole, one might also question these changes as they pertain to the teaching and learning environment. The transformative nature of educational technologies has profoundly changed pedagogical thinking and looks to revolutionize our educational system and the instructional technology choices that educators make.

Integration of technology is a complex process. However, integration is not simply about the technology choice itself, but rather, the innovative ways in which they use the technology. In order for true integration to occur, one must make careful technological choices in light of pedagogical goals and options. Educators are encouraged to look at technology as a tool used to assemble new ideas, in new ways, providing innovative approaches to old problems.

Barriers to using technology in the classroom, on multiple levels, cannot be ignored. Issues such as lack of technical support, insufficient access, lack of professional development in a technology’s use and application, as well as intimidation issues all have surfaced as legitimate
impediments to technology integration. As time passes and new instructional technologies evolve, so will the ideas of constructing academic understanding in traditional formats, and quite probably new barriers will emerge.

Individuals have perceptions about technology and each has his or her own interest in using it in the classroom. These perceptions may be related to an unwillingness or a willingness to change, may enhance or diminish technology intimidation, and may stifle or foster the integration of technology in the teaching and learning environment. Training by and for educators has been shown to support meaningful technology integration. Both formal and informal varieties provide a basis from which future integration can be imbedded in curriculum and pedagogical thinking.

Finally, the TPACK framework can be utilized as a possible way for teachers to view their own use of technology through a different lens; a way to think about integration as multifaceted and context dependent. This method of reflecting upon one's use of technology may not be ideal for every professor, every teacher, or every class; nonetheless, it provides a framework from which to cohesively consider the content being taught, the way in which it is taught and the technology used to enhance the learning process. This framework brings into perspective what an instructor is attempting to convey to their students, while simultaneously questioning, "How could one make it better?"
Chapter 3: Research Methodology

Introduction

The purpose of this study is to understand the range of ways in which the teacher participants adapt and incorporate technology into their teaching and learning environment. To that end, the study compares teachers' technology use across characteristics such as years of experience in teaching while also examining teachers’ perceptions about the level of technology integration. The results are intended to add to the current understanding of how educators utilize technology in the classroom and how this utilization, in turn, informs the kinds of support schools provide, not only to the individual teachers, but also on a school-wide basis. This study employs an embedded mixed methods approach consisting of the examination of archival lesson plans, an open-ended survey, and the TPACK questionnaire with appropriate coding and analysis of each.

The integration of technology into the classroom environment has called into question both how it is defined and what it should look like. Teachers' efforts to integrate technology into their classroom environments can serve to reveal their perceptions and reflect their interpretation of what technology integration should--or perhaps can--look like. This interpretation of integration is met with many challenges. Understanding the barriers to technology integration as perceived by teachers and the behaviors demonstrated to overcome such challenges are at the heart of this study.

Without proper professional development and a strong technical support system (Fletcher, 2006), the investment in technology may fall short of its desired goals. A teacher may have good intentions to enhance the integration of technology in his or her lessons, but a lack of proper training can allow for the misuse of these educational technologies (Butler & Sellbom,
Perceptions that teachers have about the use of technology in the teaching and learning environment also influence its use (Almekhlafi & Almeqdadi, 2010). Abdurrahman Almekhlafi and Farouq Almeqdadi (2010) state that "teachers, who were highly educated and skilled with technology, were innovative and adept at overcoming obstacles, but they did not integrate technology on a consistent basis both as a teaching and learning tool" (p. 165). Without a full understanding of the teachers’ competency and intentions with technology, it may be hard to evaluate a teacher’s use of technology and how to best support him or her to improve such use.

The goal of Chapter 3 is to explain the research design, rationale, and methods to be utilized in this study. Information necessary to advance the understanding of teachers’ perceptions concerning technology integration in the teaching and learning environment will be explored and shared. The streams of research found in Chapter 2 were designed to examine how both teachers and school district administrators perceive technology integration and the choices that they make in determining the effectiveness of how technology is used in the classroom setting.

**Research Design and Rationale**

This study of ten teachers from a secondary school will consist of an embedded mixed methods approach including the use of the quantitative TPACK questionnaire, a qualitative open-ended survey, and the examination of archival lesson plans. The intent of this design will address the emerging research questions identified in Chapter 1 and explored in Chapter 2. Data collected in this study will provide for exploratory and explanatory analysis (Creswell, 2012). This approach is well suited for this study, because "...we identify our participants and sites on purposeful sampling" (Creswell, 2012, p. 205). In trying to understand a particular phenomenon, Creswell (2012) suggests that "the researcher intentionally selects individuals and sites to learn
or understand the central phenomenon under study" (Creswell, 2012, p. 206). The standard criterion for choosing participants and sites for study is whether they are "information rich" (Patton, 1990, p. 169). The purposeful sampling found in this study will sample teachers from all four core subject areas--Mathematics, Science, Literature, and Social Studies--and it provides an information rich cross-section of technology use. Each of these different disciplines may utilize technology differently, and this study aims to explore teachers’ awareness, perception and effective use of a technological device. This researcher intends to capitalize on the strengths of both quantitative and qualitative data and provide “a very powerful mix” of findings (Miles & Huberman, 1994).

In generating an interpretation of a participant’s perspective, Joseph Maxwell (2013) states that "perspective is inherently a matter of inference from descriptions of that person's verbal behavior" (p. 103). The perspectives from the participants will be derived from both the open-ended survey responses and the TPACK questionnaire. This multi-point approach can be considered as a form of "triangulation," which would allow for a firm understanding of the teacher's perception of technology integration and effective use of a technological device. The use of open-ended survey questions, as well as archival lesson plans, will help to gain a better understanding of the "theory-in-use" (Maxwell, 2013) by each of the participants. This "theory-in-use" perspective will provide a description of both the actions and events of the day, but also intent of use and reflection upon integration. Asking participants to describe a particular event or sequence of events taps into what has been termed "episodic memory," an important and distinct neurocognitive memory system (Dere, Easton, Nadel & Huston, 2008; Tulving, 2002). It is important that we consider this sequence of events to identify the influence of barriers, frequency of use, and the intended outcomes of the technologies use. Tulving (2002) states that, "This
memory system makes possible mental "time travel," uniquely enabling someone to retrieve their previous experiences" (p. 39). This recollection of sequential events and experiences will provide the basis from which participant perspectives are compared.

Based on the proposed Model seen in Chapter 1(see Figure 5 p. 24), this study will consider each of the different elements in the following way: Sub-divisions in the TPACK questionnaire will identify components in both the construction and execution of a lesson plan. These sub-divisions will consist of Technological Knowledge (TK) (questions 1-6), Pedagogical Content Knowledge (PCK) (questions 26-29), and Technological Pedagogical Knowledge (TPK) (questions 34-42), with TK and PCK as part of lesson plan construction, and TPK as part of the execution. The archival lesson plan analysis will help to determine frequency of use and type of technology utilized.

Lesson plan analysis will help to provide an understanding of a participant’s awareness of available technologies, the application of a technology, and its utilization through the variety of and frequency of use. This variety of use was classified into both "high" and "low" categories. The analysis of lesson plans will also begin to frame how one defines technology integration by revealing what device is being used and for what purpose. The open-ended survey questions will help to determine a teachers' perspective, encountered frustrations (barriers), and factors that influenced the use or disuse of a technology. These survey questions are intended to help clarify one's perception of technology integration (also seen in lesson plan analysis), confirm awareness of available technologies (as seen in lesson plan analysis and TPACK questionnaire), and determine factors that influence repeated technology use.

As seen in the work of Ertmer (1999) and Javeri & Chen (2006), barriers to integration can be viewed as either first or second order, with first order being extrinsic to the teacher and
second order being intrinsic. It was the assumption of this researcher that the first order barriers found at the study site were imposed on all of the participating teachers, considering that each participant must operate within the same network infrastructure, compete for the same technological resources, and operate with similar equipment in their respective classrooms.

It is the second order barriers—intrinsic to the teacher—that lend themselves to comparisons of perceptions of appropriate use. In the work of Ertmer (1999), second-order barriers include beliefs about teaching with computers, established classroom practices, and an unwillingness to change their established practices. Becta (2004) also examined these second-order barriers and found that a lack of time, a lack of confidence, a lack of effective training and lack of access to resources also contributed to this type of barrier. Variations in participant perceptions of technology and appropriate use was documented, as well as confirmed by their responses to the open-ended survey.

The TPACK framework was designed to emphasize the interactions between the content being taught, the pedagogical way in which the content is to be delivered, and the technology used in the delivery of the content in a meaningful and purposeful way. The way in which a teacher approaches the use of technology also has root in the type of training that they received, both formal and informal. Both the second-order barriers and the TPACK framework overlap in areas concerning beliefs about teaching with computers, effective training, and one's awareness of available resources. The use of the TPACK questionnaire will help to capture and focus one's perceptions of technology use in the teaching and learning environment. According to NCES (2008), the highest level of technology integration is achieved only when students are able to select technology tools that help them obtain information, analyze it and synthesize that
information for future use. How one defines technology integration is dependent upon these perceptions of intended use, which is ultimately influenced by second-order barriers.

A sample of ten educators (3 English, 3 Math, 2 Science, and 2 Social Studies) participated in this study. Lesson plans were randomly selected from each participant twice a month for a duration of three months. Based on the expected format of lesson plans for the study site, each participant was required by the principal to document a week's worth of lessons electronically. This sampling resulted in 30 lessons for analysis from each of the participating teachers, culminating in 300 lesson plans total for the study.

These lesson plans were analyzed for evidence of the teachers’ intended use of technology, as well as a determination of the type of technology used, and they provided frequency data for further comparisons. Participants were also asked to complete a quantitative TPACK questionnaire (see Appendix A) which was emailed to them. Two weeks after the TPACK questionnaire was sent, participants were then asked to complete an 11-question open-ended survey pertaining to their perceptions of technology use (see Appendix B). The answers to these questions provided qualitative data, which was then coded to extrapolate patterns in perceptions, characteristics and use.

When analyzing lesson plans for frequency and intended technology use, the intended classroom activity shed some light on both the participating teacher's perception of appropriate use, and his or her ideas concerning innovative integration. Lesson plan format for the studied site had to contain the following elements: Common Core standards, Lesson Objectives - Students Will Be Able To (SWBAT); In Order To (IOT); a daily assessment; check for student understanding; Classroom Activities; and Homework assigned. A sample of this lesson plan format can be found in Appendix D. The data collected for this portion of the study was obtained
from the Classroom Activities and Assessment portions of the lesson plan. From these sections, a frequency of use as well as a description of intended use type can be derived.

The definition of technology integration in the teaching and learning environment was determined by two factors: frequency and intent, which can be found in the analysis of archival lesson plans. The archival lesson plans provided a different lens from which to view a teacher’s perceptions: through the frequency and variety of technology application. Earlier ideas of integration were based on a teacher’s perceptions of intended use, but the definition provided by NCES (2008) shifts ownership of technology integration from teacher to student. Only through proper use of a technological device--demonstrated by the teacher--can the student model a similar behavior and learn how to use the technology to demonstrate understanding of content being taught. So, it was logical to concentrate on the teacher and his or her ability to transfer technological content knowledge to students through exemplary behavior.

Documentation of a teacher’s "perceptions" surrounding the integration of technology into the teaching and learning environment was seen in both the open-ended survey questions and the TPACK questionnaire. The open-ended survey took a direct approach to framing the teachers’ perceptions, by asking the participants directly about their thoughts and choices in using technology. The TPACK questionnaire, on the other hand, took an indirect approach and considered the participants’ TK as well as PCK. Considering that none of the participating teachers has ever had any formal TPACK training, this researcher received a raw score for each of the participants. TPACK scores were compared to analysis of the open-ended survey and lesson plan data looking for confirming and conflicting evidence based on years of experience.

To enlighten this comparison, the studied participants were divided into two different categories: veteran and novice, in accordance with the definitions of each found in Chapter 1:
**Veteran Teacher:** for the purposes of this study a veteran teacher will be defined as an educator with no less than nine years of teaching experience, and who possesses or is working on a Master’s Degree.

**Novice Teacher:** an educator with less than eight years of teaching experience, and who is not working on or does not possess a Master’s Degree.

The TPACK questionnaire has a total of seven different sub-divisions, one for each of the different components of the TPACK framework. Participant’s scores were averaged together in the appropriate category and comparisons were made across all seven sub-divisions.

Hervey (2015) states, "Teachers' professional knowledge takes root over time, as they develop ideas about what it takes to be an effective teacher and how students best learn" (p. 166). This idea would support the notion that pedagogical knowledge develops over time and is a primary component of the TPACK framework. A veteran teacher would possess a greater amount of this knowledge as compared to that of novice teachers, simply because they have been teaching longer. Veteran teachers would have had the time to develop a deeper pedagogical skill set. On the other hand, Hervey (2015) goes on to state that "therefore, teachers who were taught in a traditional manner may hold on to traditional pedagogical practices when attempting to integrate technology" (p. 166). This statement could imply that although veteran teachers may possess the pedagogical knowledge, they are more reluctant to consider new and innovative means of integrating technology.

Following this line of logic, one might assume that the novice teacher would possess the ambition and likelihood to experiment with new technologies and be more receptive to integrating technology into the teaching and learning environment. It is also logical for a novice teacher’s TK and TCK to have greater overlap when compared to that of a veteran teacher. This
would result in an increase in technology integration, but at a diminished level of effectiveness. Hervey (2015) also states that "in-service (veteran teachers) fail to explore many of the affordances of computers and technology and create more engaging and constructivist-oriented pedagogy" (p. 166). This indicates that a variety of barriers are present, including the intimidation of technology, as seen in the research studies by Ertmer (1999), Javeri & Chen (2006), and Fletcher (2006). Further study into pedagogical and technological differences between veteran and novice teachers is needed, to identify the experience level that might be less susceptible to the second-order barriers encountered in the teaching and learning environment.

Site and Population

Population Description

This study looked at the level of technology integration exhibited by ten teachers in a single urban high school. The school district is a large urban district, with over 50 high schools, situated in the northeast United States of America. Over 75% of the population of the school district qualifies for free and reduced lunch. All schools in the district are considered low income schools defined by 30% or more of the population falling below the federal poverty line. As an urban school district, the population is diverse with 51% of students identifying as African-American, 20% identifying as Hispanic/Latino, 13% identifying as Caucasian and 7% identifying as multi-racial. The total enrollment of the district is approximately 134,000 K-12 students, with approximately 2,000 of these students receiving alternative education. Of the total population, 14% of students are identified as requiring special education, 1% are identified as gifted and 9% qualify as English Language Learners. The district employs over 8,000 teachers and more than 250 direct administrators (principals and assistant principals). In addition, the
district, serving as its own intermediate unit, also oversees more than 80 different charter schools with a population of over 6,000 additional students.

At the school in this study, there are over 300 students in grades 9 through 12. Of these, 93% of the student population is African American, 3% is Latino, 3% is multi-racial and 1% is Caucasian. Approximately 12% of the population is in need of special education support and less than 1% is considered English Language Learners. 85% of the student body falls into the economically disadvantaged subgroup, defined as below the federal poverty line.

The participants in this study are 10 teachers in this high school. Of the 10, seven are female and three are male, three are African American and seven are Caucasian. The teaching experience of these teachers ranges from 2 to 22 years. There are three teachers representing the Math discipline, two in Science, three in English, and two in Social Studies. The teachers range in age from 23 to 55, providing a significant potential for a variety of technological exposure.

The 10 teachers selected to participate in the study were chosen based on their full-time employment and concentration in one of the four main subject areas: Math, Science, English and Social Studies. Each of the studied participants was operating under a discipline-specific certification, issued by the state of Pennsylvania, and not under any form of emergency certification or its equivalent.

Site Description

This study took place within one school district, classified as an urban educational setting, in the state of Pennsylvania. Permission was obtained for use of the participants described above. The study site is located in the northwest region of the city, with a special-admissions program for students who thrive in a small, family-like environment. The study site consists of approximately 300 students and staff, located far away from the pressures of city
living. The site has often been referred to as "The Country Campus for the College Bound." All students are transported from their neighborhoods directly to the study site through school district bussing services. The student body is serious and goal-directed, maintaining an average daily attendance of over 90%.

The study site is relatively rich in technology, consisting of four MacBook Pro laptop carts (each containing 30 computers), two Dell Chrome Book carts (each containing 30 computers) and a 28 seat PC computer lab. There are 13 classrooms that contain either a Smart board or a Promethean board, utilized daily for instructional purposes. Based on these numbers, there are a total of 180 student laptops, 53 desktops, and 81% of active classrooms contain either a Smart board or a Promethean board. There are only three classrooms in the building that are active and do not contain these types of technologies. Each of the active classrooms contains one or two additional PC desktops intended for student use. Each teacher participating in this study was issued a MacBook Pro to conduct their daily classroom operations. The average classroom occupancy is around 32 students and the participating teachers see an average of 120 students per day.

**Site Access**

The site at which this study took place is the place of employment for the researcher. The researcher is considered the Technology Teacher Leader (TTL) for the building and has functioned in that role for the past 10 years. As TTL, one is expected to troubleshoot problems and maintain working order of all technologies—including printers and websites—and perform minor computer repair. The TTL has access to all of the technology at the site including classrooms, laptop carts, smart boards, computer labs, and various other equipment. The TTL is
also responsible for the issuing of technologies to teachers, as well as their maintenance. This responsibility allows for complete access to all computers, servers, and networks.

Research Methods

Overview of Methods

Both quantitative and qualitative methods of data collection occurred in this study. The open-ended survey questions and archival lesson plans will constitute the qualitative analysis, with the TPACK questionnaire representing the quantitative. A cross-sectional survey design, which has the advantage of measuring perceptions and practices at a given period in time, was used in phase one of the study (Creswell, 2012). This cross-sectional survey design was represented by sub-divisions found within the TPACK questionnaire. In phase two, a qualitative survey design was used, represented by an open-ended survey emailed to each of the participants for reply, without the use of follow up questions from the interviewee (Creswell, 2012).

Lesson Plan Analysis

This study utilized archival lesson plans from each of the participating teachers. Lesson plans were randomly selected from each participant twice a month for a duration of three months. Based on the expected format of lesson plans for the study site, each participant was expected by the principal to document a week's worth of lessons. The lesson plans provided the researcher with frequency of use and intent data, as it pertained to the integration of technology into the teaching and learning environment. These documents are expected to describe the intended use, lesson objective, frequency of use, and provide a valuable source of foundational information for the researcher (Creswell, 2012). Detailed knowledge about each lesson, learning objectives and anticipated outcomes will provide the researcher with an awareness of variety, frequency and intent of use. Inspecting the student activities and anticipated outcomes for
technology utilization will offer a glimpse into the participants’ preparation and application. These documents will be ready for analysis without transcription.

**Open-Ended Survey**

This study also utilized an 11-question open-ended survey in an effort to conceptualize teachers' perceptions surrounding the use of technology in their daily instruction. The open-ended survey will consider technology use from a hindsight perspective and what idealistic technology integration would look like from the participant's viewpoint. A copy of the open-ended survey questions used in this study can be found in Appendix C.

Only through a more complete understanding of the choices that teachers make concerning the use and disuse of a particular technology can one begin to understand the reasons behind the choices that were made. Could the choice that teachers make be influenced by barriers (Ertmer, 1999), or the limitations in training (Fletcher, 2006), or the time to incorporate technology into their courses (Butler & SELLbom, 2002)? It is the hope of this researcher that a more complete understanding of teachers' perceptions concerning the choices they make's in the utilization of technology will be identified through the use of these questions.

To understand an educator’s perceptions concerning technology is only half of the picture. These perceptions must also have context that contributes to choices that teachers make regarding integrating technology. To frame the context or situation from which choices are made, one must also reference the archival lesson plans for intent of use. By considering both the participants' answers to the open-ended questions, and the situational context from the lesson plan analysis, one will begin to understand the bigger picture. By considering the participants’ answers to the open-ended questions along with the situational context from the lesson plan analysis, one will begin to understand the bigger picture surrounding their perceptions of
technology in the classroom; this broader view can lead to improved methods that benefit students and their learning experience.

**TPACK Questionnaire**

This study used a quantitative questionnaire consisting of a 46-item, 5-option Likert scale design, constructed by the creators of the TPACK framework. Permission to utilize this questionnaire was obtained from the questionnaire's creators. No written permission was obtained, but rather access to retrieve the questionnaire from the creators' data server was granted. The validity and reliability of this questionnaire was independently studied by six different research studies and utilized as a form of data collection in ten others. A copy of the questionnaire answered in this study can be found in Appendix A. A list of the different research studies utilized in determining the questionnaire’s validity can be found in Appendix B.

The purpose of the TPACK questionnaire is to evaluate a teacher’s awareness of the different domains found within the TPACK framework. The validity studies found in Appendix B centered around pre-service and K-6 educators. This study will look to apply the TPACK questionnaire to in-service secondary teachers, who have not received any formal or informal TPACK training. The purpose of applying this measure to this group of teachers is to obtain a raw score for each participant. From these raw scores, comparisons will be made between years of experience across all seven sub-divisions of the questionnaire. The idea is to consider if patterns found in the sub-divisions of the questionnaire confirm or contradict participant perceptions, and to utilize this information to improve technological professional development needs.

Both the quantitative questionnaire and qualitative survey were distributed to participants through email. During the process of granting permission for their affiliation with the study,
participants were given the option to choose a particular email address at which to receive these
documents. Participants were given a two-week period in which to complete each of the items.
Reminders for completion were sent to participants every seven days, as well as a “36 hours
remaining” warning. At the conclusion of a month's time, the researcher stored all collected
responses in a password locked folder on his personal laptop until the data analysis was
completed. At the completion of this study, the participants' response data will be transferred to a
flash drive and held in an on-site secure location for the duration of four years. The researcher
will be the only person with access to the storage area. After four years’ time, the response data
will be erased from the flash drive, witnessed by the building administrator, to ensure the rights
and privacy of the participants are intact. At the conclusion of the study, the results will be
shared with the participants and building administrator, with adjustments being made if deemed
necessary by the administrator.

The following provides a sample of a few questions found in both the open-ended survey
and the TPACK questionnaire:

**Demographic Questions**

1. For how many years have you been a classroom teacher? (Cumulative Years)
2. Which of the following disciplines do you primarily teach (Math, Science, English, Social
   Studies or Other)? Please select your choice based on the greatest number of years in that
discipline.
TPACK Questionnaire Questions

<table>
<thead>
<tr>
<th>General Technology</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neither Agree or Disagree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I know how to solve my own technical problems.</td>
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<tr>
<td>2. I can learn technology easily.</td>
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<tr>
<td>3. I keep up with important new technologies.</td>
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<td>4. I frequently play around the technology.</td>
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<tr>
<td>5. I know about a lot of different technologies.</td>
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</tbody>
</table>

Open-Ended Survey Questions

1. Describe how the technology training that you received (both formal through Professional Development/Workshops/Trainings and informal through other means) has translated to use of technology in your classroom. Please share an example of something from your own classroom.

2. What do you feel is the most frustrating aspect of using technology in your classroom?

3. Recalling a technology training that you participated in, please describe the context of the training and how it "Did" or "Did not" enhance technology use in the classroom environment (either formal through Professional Development or informal through other means).

The data collected from the survey should answer all three research questions on a basic level:

1. What patterns can be seen in the ways teachers adapt technologies to their current teaching and learning environment?

2. What relationship exists between a teachers TPACK score and their perceived use of technology in their current teaching and learning environment?
3. How can one characterize teachers' decisions about technology use when viewed through the TPACK framework?

**Data Analysis Procedures**

**TPACK Questionnaire**

Upon receiving their responses participants were categorized as either veteran or novice. In accordance with the definitions of each found in Chapter 1, a veteran teacher will be defined as an educator with no less than nine years of teaching experience and who possesses or is working on a Master’s Degree. A novice teacher in turn will be an educator with less than eight years of teaching experience and who is not working on or does not possess a Master’s Degree. With participants identified and placed into their respective categories, a frequency table of participant responses was constructed to identify patterns. Patterns identified in the frequency data were then sub-divided into different sub-sections found within the TPACK questionnaire. Each of these sub-sections was then scored according to the parameters set forth by the questionnaire's creators.

According to the scoring guide that accompanied the TPACK questionnaire download, each of the Likert scale options will be assigned a number (Strongly Agree = 5 to Strongly Disagree = 1). Each of the participants' responses are to be added up and divided by the number of questions to produce an average. The calculated average can be sub-divided into each of the sub-sections (Technological Knowledge, Pedagogical Knowledge, Technological Pedagogical Knowledge, etc.). The calculated averages in each sub-section were then used for comparison between the two groups. Question-response frequencies were also used to identify specific questions in each sub-section for even further comparison.
Lesson Plan Analysis

Upon receiving these responses from each of the participants, each was categorized into either the veteran or novice classification, and a data table was constructed to determine frequency of use. Lesson plans from each participant were analyzed for mention of technology use. Lesson plans that did not explicitly state a specific use of a technology, such as PowerPoint or Achieve 3000, were not counted. Lessons that were identified to contain the use of technology were added up and divided by the total number of lesson plans collected from each participant to determine frequency of use.

Once frequency of use was determined for each participant, an analysis of intent (type) was conducted. This intent analysis was only applied to lessons that were identified to contain the use of technology. In order to determine intent or type, research from Cuban et al., (2001) was used to help categorize the identified lessons. Their work defined a low degree of technological integration as students' use of only basic applications, such as the Internet to conduct a simple search. In contrast, the development of multi-media presentations containing animations, video editing and completed projects that involve collecting and explaining data represent a high degree of integration.

Using this research as a basis of classification, definitions for both "High Integration" and "Low Integration" were developed for this study. For the purpose of this study, "High" will be defined as a classroom activity that would require interaction between a student and a computer program that can be adaptive and requires the student to provide input. "Low" will be defined as a classroom activity that does not require student interaction with a computer or software program. Each of the participants’ identified lessons were categorized and a data table was constructed for comparisons.
Open-Ended Survey

Upon receiving these responses from each of the participants--categorized into either the veteran or novice classification--a frequency table was constructed to identify the most frequent responses to each of the 11 questions. The three most frequent answers to each of questions were reported in a frequency data table (found in Chapter 4). In order to determine if cross question responses were present, a word frequency count was conducted (utilizing Google Word Cloud) for each participant, as well as for each categorical classification. This data was confirmed by the use of NVIVO software.

This researcher purchased and utilized NVIVO as the software for the analysis of the open-ended survey questions. The NVIVO software was selected for this data analysis based on the recommendation of another doctoral candidate and the demonstration of its capability at a recent technology conference. The technology conference provided an informative presentation during which both its capabilities and general operation were demonstrated. According to the presentation, the NVIVO software can import and analyze PDFs, MP3 files, documents, Excel spreadsheets, and HTML based web pages (NVIVO, 2016). Imported MP3 files can be transcribed in a much faster fashion when compared to other available software (NVIVO, 2016). Coding, word patterns and frequency, as well as comparisons and emerging themes can be completed more directly with this software. Participant open-ended survey data was imported into this program and results were generated. The analysis revealed a discernible pattern and provided the researcher with ample data from which conclusions and recommendations would be drawn.
Stages of Data Collection

The initial stage of data collection occurred toward the middle of the 2016-2017 school year. At that point, participant permission was obtained as well as email addresses to which study documentation was sent. The second phase of the data collection process occurred during a 30-day period where participants were sent both the questionnaire and survey via email. Participants were given a two-week period to complete each. Both items were sent to the participating teachers separately, but they were allowed the full 30-day window to have both items completed and returned. The timeframe selected for distribution and collection of study materials was based on the advice of the building administrator for convenience purposes. The final phase of the data collection process consisted of analysis and reporting. The data analysis began shortly after the participants' 30-day window had expired and was completed on the same personal laptop as described above.

The following table will help to describe the sequence of data collection events:

<table>
<thead>
<tr>
<th>Date:</th>
<th>Task:</th>
<th>Participants:</th>
<th>Purpose:</th>
</tr>
</thead>
<tbody>
<tr>
<td>November 1, 2016</td>
<td>Defend Proposal</td>
<td>Researcher and Committee Members: Dr. Klein Dr. Foster Dr. Mazza</td>
<td>To obtain approval and move forward with the IRB process.</td>
</tr>
<tr>
<td>November 21, 2016</td>
<td>Submit proposal to IRB</td>
<td>Researcher and Chairmen; Dr. Klein</td>
<td>To obtain the necessary approvals to conduct research.</td>
</tr>
<tr>
<td>February 10, 2017</td>
<td>Refine IRB proposal</td>
<td>Researcher and Chairmen; Dr. Klein</td>
<td>To refine the proposal based on the feedback from IRB.</td>
</tr>
<tr>
<td>March 1, 2017</td>
<td>Distribute TPACK questionnaire</td>
<td>Researcher and Participants</td>
<td>To conduct the first phase of this research study.</td>
</tr>
<tr>
<td>March 14, 2017</td>
<td>Distribute Open-ended Survey</td>
<td>Researcher and Participants</td>
<td>To conduct the second phase of this research study.</td>
</tr>
</tbody>
</table>
Beginning of April 2017 | Data Analysis | Researcher | To analyze data, identify patterns and begin the construction of chapters 4 and 5.

**Ethical Considerations**

This study will consider three areas of ethical concern: voluntary participation, confidentiality, and anonymity. The protection of the participant's rights will be of upmost importance. Each participant was asked to sign and date a letter of consent to participate in this study. A copy of this letter of consent can be found in Appendix E. Each voluntary participant will use their provided email address as the identifier at the top of both their questionnaire and survey. Only the researcher will view the questionnaire data and open-ended survey responses, and all calculations will be done by the researcher himself. No outside agencies will view any aspect of the collected data other than what is reported in this dissertation.

The only foreseen consideration is the way in which the data will be presented. Some participants may feel that the analysis of their lesson plans might be seen as an evaluative process. Each participant was reassured that only the researcher will see the lesson plans, and that reporting of data will be done in a categorical manner: only reporting years of experience. Each participant understood that the lesson plan analysis would only be used to determine frequency of use and intent, from which comparisons of their TPACK score and its sub-divisions will be made. Comparisons presented were the result of patterns found in the TPACK score sub-divisions and not the lesson plan analysis. The data presented will only reference patterns found in TPACK score sub-divisions based on the two categories mentioned above.

Raw data will not be reported in this study, nor will any identifiers such as room number, name, or race. The researcher will report average differences between novice and veteran...
participants, as well as frequency of use and word frequency data. As seen in the population description, there is more than one member of each compared discipline, so it would be very difficult—if not impossible—to identify any individual participant’s score, based on the reported averages alone.

The building administrator of the research site has given oral permission to utilize the building and staff in this research. This researcher does not anticipate any major ethical considerations surrounding this study.

**Conclusion**

We have seen how the definition of technology integration has come to mean different things to different individuals and how complex this ever-evolving concept can be. To consider how technology is used in the classroom environment, this study took into consideration a teacher’s interpretation of technology integration and their perceptions of technology use. The TPACK score and sub-divisions served to inform awareness of technologies and provide data to improve professional development. Our understanding of a teacher's perceptions of application is fundamental to conceptualizing the level of integration that students are exposed to.

The perceptions of technology’s impact on the teaching and learning environment can be different for each individual and subsequently affect the extent of its integration and innovative practices. This study sought to evaluate a teacher's perception concerning the use of technology in one of three ways. The first was done directly through the use of an open-ended survey asking participants their thoughts about technology use and how they perceive its effectiveness. The second consisted of an indirect method of examining their lesson plans for frequency and variety of technology use. The third also consisted of an indirect method, by comparing TPACK sub-scores and years of experience. The perceptions that participants have concerning the use of
technology in the classroom have a direct relationship to the level of integration that the participant displays.

The TPACK questionnaire and subsequent score sub-divisions provided a different rubric from which to compare an individual's perceptions in using technology effectively. The extent of an individual's TPACK sub-score may vary depending upon years of experience. Patterns in these categorical groups were compared for similarities and analyzed to consider if their TPACK sub-score is comparable to their perceptions concerning technology use. From the results of these comparisons one might consider corrective action surrounding perceived barriers or provide focused professional development. Participants of the survey might also use this data to identify individuals as technological leaders, to help improve integration and innovation efforts across the entire study site. Recommendations derived from this data analysis will be shared with the stakeholders of the participating school district and Drexel University for academic purposes. This study did not take into account any participant's sex, race, religion, or class size.

This embedded mixed methods approach was designed to identify patterns in perceptions pertaining to technology use and how comparing these perceptions to raw TPACK sub-scores might identify patterns related to experience. The utilization of both the questionnaire and survey served to compare teacher intent and perceived outcome. Visualize what happens when a person places a straw in a glass of water. When he or she looks at the glass straight on the observer notices that the straw is straight. But, when the glass is viewed from the side, the straw appears distorted. This study looked to identify a similar distortion or pattern when applied to educators’ perceptions of innovative practices for both commonplace and emerging technologies.

Computers can effectively support meaningful learning and knowledge construction as a cognitive tool for reflecting on what students have learned and what they already know. Rather
than using computer technologies to disseminate information, they should be used in all subject domains as tools for engaging learners in reflective and critical thinking about the ideas they are studying through innovative practices.
Chapter 4: Finding, Results, and Interpretations

Introduction

The purpose of this study is to examine the ways in which teachers in a small urban secondary school are integrating technology into their classrooms. This study looked to identify elements of experiences that can be used to inform and improve the design of training opportunities. The choices that teachers make in considering technology integration for educational activities may be influenced by a variety of different opportunities and barriers. By examining how teachers adapt and incorporate technology into their classrooms, we can begin to enrich our understanding of the barriers and experiences--including varied perceptions of these barriers--to design a more meaningful professional development. To fulfill this purpose, an embedded mixed methods approach was utilized and consisted of archival lesson plan analysis, an open-ended survey, and the TPACK questionnaire with appropriate coding and analysis of each.

Findings

Lesson Plan Analysis

This analysis began by identifying the "type" and frequency of technologies reported over a 30-day period, for each participant. This resulted in 30 archival lesson plans per participant and 300 lesson plans for the study. This study revealed that the utilization of technology by both veteran and novice participants was about equal, as seen in Table #2 below. The areas with a gray fill are considered "Novice" teachers (1-8 years of experience) and the areas without gray fill are considered "Veteran" teachers (11-20 years of experience). This pattern of color identifiers will remain the same for the duration of this chapter.
The data from the lesson plan analysis provided no significant difference between the
groups possibly due to the small sample size. Further study may be warranted on a larger sample
to obtain a clearer result. A summary of the comparisons made, as well as their results are as
follows. Table #2 below indicates the frequency of use by each participant over a 30-day period.

Table 2

*Frequency of Use*

<table>
<thead>
<tr>
<th>Participant Number</th>
<th>Reported Use Over 30 Days</th>
<th>Frequency of Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>207N</td>
<td>11</td>
<td>0.366</td>
</tr>
<tr>
<td>210V</td>
<td>11</td>
<td>0.366</td>
</tr>
<tr>
<td>203N</td>
<td>10</td>
<td>0.333</td>
</tr>
<tr>
<td>206V</td>
<td>11</td>
<td>0.366</td>
</tr>
<tr>
<td>209N</td>
<td>13</td>
<td>0.433</td>
</tr>
<tr>
<td>308N</td>
<td>15</td>
<td>0.5</td>
</tr>
<tr>
<td>305V</td>
<td>19</td>
<td>0.633</td>
</tr>
<tr>
<td>307N</td>
<td>19</td>
<td>0.633</td>
</tr>
<tr>
<td>213V</td>
<td>19</td>
<td>0.633</td>
</tr>
<tr>
<td>204V</td>
<td>25</td>
<td>0.833</td>
</tr>
</tbody>
</table>

The mean reported use \((N = 10)\) for the data set is 15.3, with a standard deviation of 4.98. When
this data was categorized into veteran and novice participant groups, the veteran group reported
\((N = 5, M = 17, SD = 6)\) and the novice participant group reported \((N = 5, M = 13.6, SD = 3.57)\).

A two-tailed \(t\)-test with \(\alpha = 0.05\) was run using SPSS to compare the difference between
the veteran and novice reported technology use over the 30-day period sample period. The two-
tailed \(t\)-test resulted in a non-significant value of \(p = 0.154\), indicating there is no difference
between the technology use of veteran and novice participants. This result was also confirmed by
an analysis of frequency data reported by each of the groups. The mean reported \((N = 10)\)
frequency of use for the data set was found to be 0.525, with a standard deviation of 0.168.

Veteran participants reported a frequency of use of \((N = 5, M = 0.566, SD = 0.2)\) and the novice
participant group reported \((N = 5, \ M = 0.453, \ SD = 0.119)\). A two-tailed \(t\)-test with \(\alpha = 0.05\) also resulted in a non-significant value.

The lesson plan analysis further categorized the way in which a participant was utilizing the technologies. Categories of technology applications were based upon the work of Cuban, et al., (2001). Their work defined a low degree of technological integration as students' use of only basic applications, such as the Internet to conduct a simple search or Google to obtain images. In contrast, the development of multi-media presentations containing animation, video editing and completing projects that involve collecting and explaining data represent a high degree of integration.

Building on the work of Cuban et. al., this study classifies "High" and "Low" as follows. "High" is defined as a classroom activity that would require interaction between a student and a computer program that can be adaptive and requires the student to provide input. "Low" is defined as a classroom activity that does not require student interaction with a computer or software program.

Table 3 found below, provides examples found within collected lesson plans, and classified according to type.

**Table 3**

<table>
<thead>
<tr>
<th>Classification Type</th>
<th>High Type</th>
<th>Low Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Examples Found</td>
<td>Khan Academy Article</td>
<td>PPT Lecture Notes</td>
</tr>
<tr>
<td></td>
<td>Utilize Naviance: Pre-College</td>
<td>Board Problems</td>
</tr>
<tr>
<td></td>
<td>Achieve 3000 Assignment</td>
<td>Present Projects (PPT)</td>
</tr>
<tr>
<td></td>
<td>CK-12 Article Assignment</td>
<td>Review Notes on Smartboard</td>
</tr>
<tr>
<td></td>
<td>Compass Learning Activity</td>
<td>Read Passage Online</td>
</tr>
<tr>
<td></td>
<td>Create Google Doc and Share with Teacher</td>
<td>Read Passage from Overhead</td>
</tr>
<tr>
<td></td>
<td>Kahoot Review Game</td>
<td>Watch Videos</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Google Search for Articles</td>
</tr>
</tbody>
</table>
The breakdown of technology type was also applied to both the veteran and novice groups. The veteran participant group \((N = 5)\) was found to have a High Type mean \((M_{Ht})\) of 7 with a standard deviation of 2.915 and a Low Type mean \((M_{Lt})\) of 10 with a standard deviation of 7.968. The novice participant group \((N = 5)\) was found to have a \((M_{Ht} = 6.6, SD = 2.701\) and \(M_{Lt} = 7, SD = 5.567\).

A two-tailed \(t\)-test with \(\alpha = 0.05\) was run using SPSS to compare the difference between veteran participant reported High and Low Technology Types. The two-tailed \(t\)-test resulted in a non-significant value of \(p = 0.451\), indicating there is no difference between the technology use type of veteran participants. This same test was used to compare the High and Low Technology Types for the novice participants, again a non-significant value of \(p = 0.888\) was found, indicating there is no difference between the technology use type of novice participants.

Further comparisons were also made between: veteran High Type \((V_{Ht})\) and novice High Type \((N_{Ht})\), veteran Low Type \((V_{Lt})\) and novice Low Type \((N_{Lt})\), \(V_{Ht}\) and \(N_{Lt}\), and \(V_{Lt}\) and \(N_{Ht}\); utilizing the same two-tailed \(t\)-test with \(\alpha = 0.05\) through SPSS. The following Table #4 depicts the results of these comparisons:
Table 4

Comparison Between Groups

<table>
<thead>
<tr>
<th>Comparison Groups and Type</th>
<th>Significance Value ($p$)</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{Hi}$ and $N_{Hi}$</td>
<td>0.827</td>
<td>indicating there is no difference between the High technology use type of veteran and novice participants.</td>
</tr>
<tr>
<td>$V_{Li}$ and $N_{Li}$</td>
<td>0.509</td>
<td>indicating there is no difference between the Low technology use type of veteran and participants.</td>
</tr>
<tr>
<td>$V_{Li}$ and $N_{Hi}$</td>
<td>0.352</td>
<td>indicating there is no difference between the High technology use type of novice participants and the Low technology use type of veteran participants.</td>
</tr>
<tr>
<td>$V_{Hi}$ and $N_{Li}$</td>
<td>1.0</td>
<td>indicating there is no difference between the High technology use type of veteran participants and the Low technology use types of novice participants.</td>
</tr>
</tbody>
</table>

Although these results did not indicate any significant differences between the comparisons made, further study is necessary on larger sample sizes to identify any perception and usage differences between these participant groups. Once a significant difference is identified between the groups, it is anticipated that the TPACK questionnaire will be utilized to explain the significance found within the lesson plan analysis.

TPACK Questionnaire Analysis

The TPACK questionnaire is divided into several sections, each considering a different aspect of the TPACK framework. The seven sub-divisions of this questionnaire consist of: Technological Knowledge (TK), Content Knowledge (CK), Pedagogical Knowledge (PK), Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK), Technological Pedagogical Knowledge (TPK), and Technological Pedagogical Content Knowledge (TPACK). For the purpose of this study three of the seven sub-divisions of the questionnaire were examined for comparison. The three sub-sections that were analyzed are as
follows: Technological Knowledge (questions 1-6), Pedagogical Content Knowledge (questions 26-29), and Technological Pedagogical Knowledge (questions 34-42). These three in particular were found to have the greatest difference in reported averages amongst the veteran and novice participant groupings. Each of these sub-sections will be discussed in detail, providing frequency data tables and averaged veteran and novice question scores for each section.

The first sub-division considered was Technological Knowledge (questions 1-6). Technological Knowledge is considered the knowledge to correctly operate computers, tablets, video recording devices, projectors, speakers, and other electronic devices that aid in the processing of information (Sahin, Celik, Akturk & Aydin, 2013). The analysis found that these responses had distinct differences between novice and veteran participant sub-division response averages. Table 5 (found below) will summarize this first set of results:

Table 5

<table>
<thead>
<tr>
<th>Group Type</th>
<th>Veteran Participants</th>
<th>Novice Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>TK Sub-Division Average</td>
<td>2.9</td>
<td>3.9</td>
</tr>
<tr>
<td>Score</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average Difference</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

Questions concerning one's up keep with important new technologies (#3), and one's knowledge about a lot of different technologies (#5), showed the greatest average response differences between the groups.

The second division considers Pedagogical Content Knowledge (questions 26-29). Pedagogical Content Knowledge is a combination of different teaching elements, such as a knowledge of subject matter, students and possible misconceptions, as well as knowledge of general pedagogy. PCK is knowing what, when, why, and how to teach specific content. PCK is
the way in which the instructor chooses to deliver the content. One could choose from a variety of different methods, such as: group collaboration, note taking, small group discussions, or even lecture. A skilled instructor will effectively choose which method of delivery is best suited for the students they are instructing (Wright & Wilson, 2011). The analysis found that these responses had many similarities between both the veteran and novice participants. Table 6 (found below) will summarize this second set of results:

**Table 6**

*Difference Between Group Type for Pedagogical Content Knowledge*

<table>
<thead>
<tr>
<th>Group Type</th>
<th>Veteran Participants</th>
<th>Novice Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCK Sub-Division Average Score</td>
<td><strong>4.1</strong></td>
<td><strong>3.3</strong></td>
</tr>
<tr>
<td><strong>Average Difference</strong></td>
<td></td>
<td><strong>0.8</strong></td>
</tr>
</tbody>
</table>

In this sub-division responses to questions 26, 27 and 29 stand out as providing the greatest difference in average question score. Question 27 in particular, was found to have an average question score difference of (1.4). This data would indicate that veteran participants have a greater understanding of how to deliver specific content.

The third and final division considers Technological Pedagogical Knowledge (questions 34-42). Technological Pedagogical Knowledge is the knowledge responsible for determining which technology would best fit the method of instruction delivery. This type of knowledge will allow for the proper choice of technology to co-inside with the selected instructional technique. Table 7, found below displays this third set of results.
Table 7

**Difference Between Group Type for Technological Pedagogical Knowledge**

<table>
<thead>
<tr>
<th>Group Type</th>
<th>Veteran Participants</th>
<th>Novice Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>TPK Sub-Division Average</td>
<td>3.2</td>
<td>4</td>
</tr>
<tr>
<td>Score</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average Difference</td>
<td></td>
<td>0.8</td>
</tr>
</tbody>
</table>

Questions concerning thinking critically about how to use technology in the classroom (#37), and how to adapt the use of technologies to different teaching activities (#38), showed the greatest average response differences between the groups.

For the purpose of being non-repetitive, the following summative data tables 9 and 10 were constructed. Table 8 displays a participants’ average score per all seven sections of the TPACK questionnaire. Table 9 depicts the average veteran and novice group score per all seven sections, as well as score differences between the groups.

Table 8

**Participant’s Average Score Per Section**

<table>
<thead>
<tr>
<th>Participant Number</th>
<th>(TK)</th>
<th>(CK)</th>
<th>(PK)</th>
<th>(PCK)</th>
<th>(TCK)</th>
<th>(TPK)</th>
<th>(TPACK)</th>
</tr>
</thead>
<tbody>
<tr>
<td>207N</td>
<td>4</td>
<td>4.7</td>
<td>4.6</td>
<td>3.7</td>
<td>3.7</td>
<td>4.5</td>
<td>3.7</td>
</tr>
<tr>
<td>210V</td>
<td>4.3</td>
<td>3.8</td>
<td>4.4</td>
<td>3.7</td>
<td>3.7</td>
<td>4</td>
<td>3.5</td>
</tr>
<tr>
<td>203N</td>
<td>3.8</td>
<td>4</td>
<td>3.8</td>
<td>3.5</td>
<td>3.7</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>206V</td>
<td>2</td>
<td>4.5</td>
<td>5</td>
<td>5</td>
<td>3.2</td>
<td>3.1</td>
<td>3.5</td>
</tr>
<tr>
<td>209N</td>
<td>4.5</td>
<td>3</td>
<td>4.5</td>
<td>3.2</td>
<td>3.5</td>
<td>4</td>
<td>3.5</td>
</tr>
<tr>
<td>308N</td>
<td>3.8</td>
<td>3.8</td>
<td>4.5</td>
<td>3</td>
<td>3</td>
<td>3.8</td>
<td>3</td>
</tr>
<tr>
<td>305V</td>
<td>2.8</td>
<td>4.2</td>
<td>4.2</td>
<td>4</td>
<td>2.7</td>
<td>3.5</td>
<td>3.7</td>
</tr>
<tr>
<td>307N</td>
<td>3.5</td>
<td>3.5</td>
<td>4.2</td>
<td>3.5</td>
<td>3.5</td>
<td>4</td>
<td>3.5</td>
</tr>
<tr>
<td>213V</td>
<td>2.1</td>
<td>3</td>
<td>4.4</td>
<td>3.5</td>
<td>4</td>
<td>2.3</td>
<td>1.2</td>
</tr>
<tr>
<td>204V</td>
<td>3.5</td>
<td>4.5</td>
<td>4.7</td>
<td>4.5</td>
<td>3.5</td>
<td>3.2</td>
<td>4.7</td>
</tr>
</tbody>
</table>
Table 9

Veteran and Novice Average Score Per Section

<table>
<thead>
<tr>
<th>Group Type</th>
<th>(TK)</th>
<th>(CK)</th>
<th>(PK)</th>
<th>(PCK)</th>
<th>(TCK)</th>
<th>(TPK)</th>
<th>(TPACK)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Veteran Participants</td>
<td>2.9</td>
<td>4</td>
<td>4.5</td>
<td>4.1</td>
<td>3.4</td>
<td>3.2</td>
<td>3.3</td>
</tr>
<tr>
<td>Novice Participants</td>
<td>3.9</td>
<td>3.8</td>
<td>4.3</td>
<td>3.3</td>
<td>3.5</td>
<td>4</td>
<td>3.5</td>
</tr>
<tr>
<td>Difference</td>
<td>1</td>
<td>0.2</td>
<td>0.2</td>
<td>0.8</td>
<td>0.1</td>
<td>0.8</td>
<td>0.2</td>
</tr>
</tbody>
</table>

The TPACK score difference of (0.2) between the two groups, shows little difference between the veteran and novice groups. The data did reveal that the sub-divisions of Technological Knowledge (TK) and Technological Pedagogical Knowledge (TPK) favored that of the novice participant, while the Pedagogical Content Knowledge (PCK) score of (0.8) favored that of veteran participants. This would indicate that novice participants keep up with important new technologies and possess a wide range of different technologies that would best fit the method of instruction delivery. The data also points to veteran participants possessing a greater understanding of what, when, why, and how to teach specific content. These participants also possess a broader pedagogical base from which to draw methodology from.

Open-Ended Survey Analysis

An analysis of the open-ended survey data revealed similar results to those found in the TPACK questionnaire. A word frequency count was first applied to each of the participant's responses in order to determine frequency and response patterns across all questions. Individual as well as veteran and novice participant grouped responses were placed in a Google Word Cloud to determine frequency of word use. The 11 questions asked in this survey were omitted, so as not to include these phrases in the frequency count. Only the participants’ responses were used to generate these results. Tables 10, 11, and 12 summarize the data:
Table 10

*Word Frequency of Response for All Participants*

<table>
<thead>
<tr>
<th>Word</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students</td>
<td>60</td>
</tr>
<tr>
<td>Technology</td>
<td>45</td>
</tr>
<tr>
<td>Classroom</td>
<td>26</td>
</tr>
<tr>
<td>Time</td>
<td>18</td>
</tr>
</tbody>
</table>

Table 11

*Word Frequency of Response for Novice Teachers*

<table>
<thead>
<tr>
<th>Word</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students</td>
<td>37</td>
</tr>
<tr>
<td>Technology</td>
<td>24</td>
</tr>
<tr>
<td>Classroom</td>
<td>21</td>
</tr>
<tr>
<td>Computer</td>
<td>10</td>
</tr>
</tbody>
</table>

Table 12

*Word Frequency of Response for Veteran Teachers*

<table>
<thead>
<tr>
<th>Word</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students</td>
<td>21</td>
</tr>
<tr>
<td>Technology</td>
<td>20</td>
</tr>
<tr>
<td>Time</td>
<td>13</td>
</tr>
<tr>
<td>Notes</td>
<td>8</td>
</tr>
</tbody>
</table>

In this analysis, both the veteran and novice groups used the words "Students" and "Technology" with the greatest of frequency. The novice participants reported "Classroom" and "Computer" as the next most frequently used words, which differs from that of the veteran participant responses. For veteran participants, the next most frequently used words were found to be "Time" and "Notes", indicated by the gray fill in the above data tables. The frequency of word use by each of the different groups will provide some insight into the general perceptions
concerning the use of technology. Individual word frequencies are found below in participant summary profiles.

A summary profile of each participant is provided. In the following sections, each participant will be examined individually, highlighting data obtained from each of the three instruments used in this study in order to paint a more holistic picture of each participant. Three of the eleven questions asked were selected to identify beliefs about what successful technology integration would look like (definition), most frustrating aspects of using technology (barriers), and what factors were considered when choosing the use or disuse of a technology (perception). Quotes from each participant are included for later comparison and a determination of characteristics and trends.

Participant 207 (207N) is a novice English teacher. The Lesson Plan Analysis revealed that over a 30-day sampling this instructor documented the use of technology 11 times, resulting in a utilization frequency of 0.366. Of the 11 occurrences, all were found to be "High" in nature. The TPACK Questionnaire revealed that this individual scored the following in Table 13.

<table>
<thead>
<tr>
<th>Technological Knowledge</th>
<th>Pedagogical Content Knowledge</th>
<th>Technological Pedagogical Knowledge</th>
<th>TPACK Score</th>
<th>Open-Ended Survey word frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>3.7</td>
<td>4.5</td>
<td>3.7</td>
<td>Computers (12), Students (9) Technology (7), Classroom (6) School (4).</td>
</tr>
</tbody>
</table>

This participant believes that successful technology integration would look like "all students are engaged," and the "increase of internet literacy skills." 207N also feels that the most frustrating aspect of using technology is the lack of technology support; she wrote: "I feel less equipped to
help students when they are having problems with a Mac." When considering the use or disuse of a technology in the classroom, this participant felt that student classroom access to the technology was most important.

Participant 206 (206V) is a veteran English teacher. The Lesson Plan Analysis revealed that over a 30-day sampling, this individual documented the use of technology 11 times, resulting in a utilization frequency of 0.366. Of the 11 occurrences, 7 were found to be "High" and 4 were found to be "Low" in nature. The TPACK Questionnaire revealed that this individual scored the following in Table 14.

**Table 14**

*Summative Data for Participant 206V*

<table>
<thead>
<tr>
<th>Technological Knowledge</th>
<th>Pedagogical Content Knowledge</th>
<th>Technological Pedagogical Knowledge</th>
<th>TPACK Score</th>
<th>Open-Ended Survey word frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>5</td>
<td>3.1</td>
<td>3.5</td>
<td>Text (4), Online (2), and Book (2).</td>
</tr>
</tbody>
</table>

206V believes that successful technology integration includes "the use of video, online textbook or a computer-based program." 206V also feels that the most frustrating aspect of using technology is the lack of resources: "The lack of individual computers and older technologies in the school." When considering the use or disuse of a technology in the classroom, this participant felt that a lack of available resources in both the classroom and school wide was the most important aspect.

Participant 305 (305V) is a veteran English teacher. The Lesson Plan Analysis revealed that over a 30-day sampling, this individual documented the use of technology 19 times, resulting in a utilization frequency of 0.633. Of the 19 occurrences, 8 were found to be "High"
and 11 were found to be "Low" in nature. The TPACK Questionnaire revealed that this individual scored the following in Table 15.

**Table 15**

**Summative Data for Participant 305V**

<table>
<thead>
<tr>
<th>Technological Knowledge</th>
<th>Pedagogical Content Knowledge</th>
<th>Technological Pedagogical Knowledge</th>
<th>TPACK Score</th>
<th>Open-Ended Survey word frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.8</td>
<td>4</td>
<td>3.5</td>
<td>3.7</td>
<td>Students (7), Technology (4), and Time (3).</td>
</tr>
</tbody>
</table>

This participant believes that successful technology integration would look like "all students are engaged and facilitates individualization of instruction." 305V feels that the most frustrating aspect of using technology is the lack of support: "There's no support. I might have a problem bringing it all in at the same time, since some kids would need more technical help than others." When considering the use or disuse of a technology in the classroom, this participant felt that lack of preparation time was most important.

Participant 213 (213V) is a veteran Math teacher. Lesson Plan Analysis revealed that over a 30-day sampling, this individual documented the use of technology 19 times, resulting in a utilization frequency of 0.633. Of the 19 occurrences, 3 were found to be "High" and 16 were found to be "Low" in nature. The TPACK Questionnaire revealed that this individual scored the following in Table 16.

**Table 16**

**Summative Data for Participant 213V**

<table>
<thead>
<tr>
<th>Technological Knowledge</th>
<th>Pedagogical Content Knowledge</th>
<th>Technological Pedagogical Knowledge</th>
<th>TPACK Score</th>
<th>Open-Ended Survey word frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>3.5</td>
<td>2.3</td>
<td>1.2</td>
<td>Notes (7), Problems (7), Students (5), Practice (4), and Computers (4).</td>
</tr>
</tbody>
</table>
213V believes that successful technology integration would look like "Students are on task, reading instructions and collaborating for answers." 213V feels that the most frustrating aspect of using technology is the lack of application time: "The class period is too short to be able to explain the activity and hand out computers." When considering the use or disuse of a technology in the classroom, 213V felt that lack of application time was most important.

Participant 210 (210V) is a veteran Math teacher. Lesson Plan Analysis revealed that over a 30-day sampling, this individual documented the use of technology 11 times, resulting in a utilization frequency of 0.366. Of the 11 occurrences, all were found to be "High" in nature. The TPACK Questionnaire revealed that this individual scored the following in Table 17.

**Table 17**

<table>
<thead>
<tr>
<th>Summative Data for Participant 210V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technological Knowledge</td>
</tr>
<tr>
<td>--------------------------</td>
</tr>
<tr>
<td>4.3</td>
</tr>
</tbody>
</table>

210V believes that successful technology integration would look like "Students are engaged both in the lesson as well as interacting positively and productively." 210V also feels that the most frustrating aspect of using technology is the lack of learn time: "I do not always have the time to utilize technology to its fullest capacity, due to time constraints as well as the lack of formal training". When considering the use or disuse of a technology in the classroom, this participant felt that the lack of comfort with a technology was most important.

Participant 204 (204V) is a veteran Social Studies teacher. Lesson Plan Analysis revealed that over a 30-day sampling, this individual documented the use of technology 25 times,
resulting in a utilization frequency of 0.833. Of the 25 occurrences, 6 were found to be "High" and 19 were found to be "Low" in nature. The TPACK Questionnaire revealed that this individual scored the following in Table 18.

Table 18

**Summative Data for Participant 204V**

<table>
<thead>
<tr>
<th>Technological Knowledge</th>
<th>Pedagogical Knowledge</th>
<th>Technological Pedagogical Knowledge</th>
<th>TPACK Score</th>
<th>Open-Ended Survey word frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.5</td>
<td>4.5</td>
<td>3.2</td>
<td>4.7</td>
<td>Time (4), Technology (3), and Students (3).</td>
</tr>
</tbody>
</table>

204V believes that successful technology integration would look like "Using the laptop and websites that help students to better understand the material at hand." 204V feels that the most frustrating aspect of using technology is the lack of learn time: "The time to put things together...and how no matter what I learn about technology, the next day it seems to be something new." When considering the use or disuse of a technology in the classroom, 204V felt that the lack of time to learn new technology was most important.

Participant 203 (203N) is a novice Social Studies teacher. Lesson Plan Analysis revealed that over a 30-day sampling, this individual documented the use of technology 10 times, resulting in a utilization frequency of 0.333. Of the 10 occurrences, 6 were found to be "High" and 4 were found to be "Low" in nature. The TPACK Questionnaire revealed that this individual scored the following in Table 19.
Table 19

*Summative Data for Participant 203N*

<table>
<thead>
<tr>
<th>Technological Knowledge</th>
<th>Pedagogical Content Knowledge</th>
<th>Technological Pedagogical Knowledge</th>
<th>TPACK Score</th>
<th>Open-Ended Survey word frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.8</td>
<td>3.5</td>
<td>4</td>
<td>4</td>
<td>Classroom (4), Exploration (3), and Computers (1).</td>
</tr>
</tbody>
</table>

203N believes that successful technology integration would look like "A flipped classroom, with lectures at home, and activities and games in class." 203N also feels that the most frustrating aspect of using technology is the lack of resources: "Not having resources, no computer cart for classroom or group work." When considering the use or disuse of a technology in the classroom, 203N felt that the lack of available resources was most important.

Participant 209 (209N) is a novice Math teacher. Lesson Plan Analysis revealed that over a 30-day sampling, this individual documented the use of technology 13 times, resulting in a utilization frequency of 0.433. Of the 13 occurrences, 7 were found to be "High" and 6 were found to be "Low" in nature. The TPACK Questionnaire revealed that this individual scored the following in Table 20.

Table 20

*Summative Data for Participant 209N*

<table>
<thead>
<tr>
<th>Technological Knowledge</th>
<th>Pedagogical Content Knowledge</th>
<th>Technological Pedagogical Knowledge</th>
<th>TPACK Score</th>
<th>Open-Ended Survey word frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.5</td>
<td>3.2</td>
<td>4</td>
<td>3.5</td>
<td>Learning (11), Students (9), and Technology (8).</td>
</tr>
</tbody>
</table>

209N believes that successful technology integration would look like "Technology that helps provide student understanding and individualized learning paths for various learners." 209N also
feels that the most frustrating aspect of using technology is the lack of student understanding: "Having students understand the process and getting them dedicated to the use of the technology." When considering the use or disuse of a technology in the classroom, this participant felt that the ease of use was most important.

Participant 308 (308N) is a novice Science teacher. Lesson Plan Analysis revealed that over a 30-day sampling, this individual documented the use of technology 15 times, resulting in a utilization frequency of 0.5. Of the 15 occurrences, 4 were found to be "High" and 11 were found to be "Low" in nature. The TPACK Questionnaire revealed that this individual scored the following in Table 21.

**Table 21**

**Summative Data for Participant 308N**

<table>
<thead>
<tr>
<th>Technological Knowledge</th>
<th>Pedagogical Content Knowledge</th>
<th>Technological Pedagogical Knowledge</th>
<th>TPACK Score</th>
<th>Open-Ended Survey word frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.8</td>
<td>3</td>
<td>3.8</td>
<td>3</td>
<td>Technology (6), Students (4), and Website (3).</td>
</tr>
</tbody>
</table>

308N believes that successful technology integration would look like "All students answer questions through the website and immediately receive feedback. The website also has analysis data to help the teacher." 308N feels that the most frustrating aspect of using technology is the lack of technology support: "When students need technology support, it really slows things down, since I could only do one thing at a time." When considering the use or disuse of a technology in the classroom, 308N felt that student understanding was most important.

Participant 307 (307N) is a novice Science teacher. Lesson Plan Analysis revealed that over a 30-day sampling, this individual documented the use of technology 19 times, resulting in a utilization frequency of 0.633. Of the 19 occurrences, 5 were found to be "High" and 14 were
found to be "Low" in nature. The TPACK Questionnaire revealed that this individual scored the following in Table 22.

Table 22

**Summative Data for Participant 307N**

<table>
<thead>
<tr>
<th>Technological Knowledge</th>
<th>Pedagogical Knowledge</th>
<th>Technological Pedagogical Knowledge</th>
<th>TPACK Score</th>
<th>Open-Ended Survey word frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.5</td>
<td>3.5</td>
<td>4</td>
<td>3.5</td>
<td>Student (10), Classroom (9), and Technology (5).</td>
</tr>
</tbody>
</table>

307N believes that successful technology integration would look like "Technology should be accessible in the classroom to every student, so that lessons can easily transition from lecture and notes to digital interactions and assessments." 307N also feels that the most frustrating aspect of using technology is the lack of technology support: "When the internet is not available, or an application is not working properly." When considering the use or disuse of a technology in the classroom, 307N felt that student understanding of the lesson objectives was most important.

Participant’s responses to each question of the survey are shared in Table 24 below. This frequency table was constructed to identify the most frequent response to each of the 11 questions. The questions were expected to have multiple responses by the participants, with the three most frequent answers to each reported. Questions 1 and 2 pertained to years of experience and discipline taught and are not included in this table. Question 7 pertained to a specific use of technology in a particular lesson. This data was also reported in the lesson plan analysis for frequency and type. The responses for question 7 only helped to confirm lesson plan analysis results, and therefore are also not included in this table. Question 10 pertained to technology training received, similar to question 8. Question 10's responses were used to confirm the results.
found in question 8, and not included in the table. The data table below summarizes the findings of this initial analysis: *Items highlighted in the table had a difference of 2 or greater.*

Table 23

*Participant Open-Ended Survey Response Results*

<table>
<thead>
<tr>
<th>Question Number</th>
<th>Question Asked</th>
<th>Response</th>
<th>Veteran Frequency of Response</th>
<th>Novice Frequency of Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Can you describe what you think successful technology integration looks like in the classroom?</td>
<td>Students are engaged</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Help teacher with instruction</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Better student understanding</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>Can you describe how you learned to use technology both personally and in your classroom?</td>
<td>Trial and Error</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Workshop or PD</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Friends and Co-Workers</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hands on Use / Read Article</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>5</td>
<td>In what ways have you (or do you) learn about new technologies for the classroom? (Blog, Professional Development (PD), Friend, Conference)</td>
<td>PD</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Friends and Co-Workers</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Personal Use</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>When you plan a unit of study, how often, and to what extent do you utilizing technology as part of your lesson?</td>
<td>Every Lesson</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Once per Week</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>8</td>
<td>Describe how the technology training that you received (both formal through Professional Development/Workshops/Trainings and informal through other means) has translated to use of technology in your classroom. Please share an</td>
<td>Google Classroom</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Smart board Use</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Compass Learning</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>
Both veteran and novice participants seem to agree that when technology is successfully integrated, students should be engaged and it should serve to enhance instruction and understanding. But, when one considers how veteran and novice participants learned to use technologies (question 4), some differences begin to emerge. Novice participants favored hands-on use, while veteran participants favored trial and error. Novice participants expressed the need to work with and explore the functionality of technology before deciding the use or disuse of a technology. Veteran participants, on the other hand did not express these same notions, rather choosing trial and error occurrences to determine a technology’s use. Novice participants would seem to gravitate toward "learn time", the time delegated to exploring the functional usefulness and operation of a technology, which naturally results in a need for that time in the "awareness of technology" process.

Another disparity can also be found in the utilization of technology in a lesson (question 6). Veterans reported use of technology on a daily basis, but this data is contradicted by the lesson plan analysis. According to the data obtained from the collected lesson plans, the frequency of use between veteran and novice participants is about equal. Novice participants reported technology use only once per week, similar to what was found in their lesson plan analysis.
The primary emerging difference between veteran and novice participants is their perception of time investment. In both cases, when teachers were asked about the most frustrating aspects factoring into technology use, veteran participants found this to be a lack of time to acquire, learn, and incorporate; while novice participants found it to be lack of technology support (question 9). This lack of support found in novice participants can be interpreted as the time needed to consult an expert, who may or may not be available, or as the needed time to be invested seeking out a solution to their technological difficulty.

This difference in perception concerning time may also have roots in the perceived value of technologies use verses student benefit. Recalling that the lesson plan analysis revealed that novice participants had a tendency to implement more "high order" activities than veteran participants, this might also indicate a greater perceived value in classroom activities by novice participants. This perception can also be found in the Technological Knowledge (questions 1-6) section of the TPACK questionnaire.

Results and Interpretations

The data collection methods described above point to both time and support as emerging factors in this study. Time was viewed as an obstacle in more than one way, suggesting that supporting teachers’ notions of time as a barrier may involve different types of professional development. One could consider “time” to mean frequency of use, or one might view “time” as the period needed to prepare a lesson. The different perspectives of time reflect distinct values among individual teachers. Some may find more time value in learning to use a technology than becoming aware of one. Others may find time better spent in preparing a lesson with technology than fully learning how to use it. Veteran participants, in particular, point to this difference in perceived time values, both in the TPACK questionnaire and open-ended survey.
This study has identified four different time barriers that teachers face when attempting to integrate technology into the teaching and learning environment. These four-time barriers are:

- Time for Awareness
- Time to Learn
- Time to Apply
- Time to Utilize

Each is critical in the decision-making process of adhering a new technology to a lesson or innovating an existing classroom activity. These different sub-divisions of time are alluded to in the open-ended survey responses and confirmed in the TPK sub-section to the TPACK questionnaire. The following sections will explore each of these different sub-divisions of time and provide evidence from the different data collection measures used in this study.

**Time for Awareness**

The Hora and Holden (2013) research study examined the role that instructional technologies play in teacher reform efforts. The researchers looked at three distinct areas: (a) awareness of local resources for instructional technologies, (b) decision making processes regarding technology use, and (c) actual classroom use of the technology. The awareness of local resources for instructional technologies within the context of time barriers will be considered in this section; decision making and classroom use will be addressed in subsequent sections.

“Time for awareness”, in this study will be considered the time required to seek out and identify technologies that might be of some instructional benefit to the student. Participant 204V identifies this time for awareness as "the time to put things together...and how no matter what I learn about technology, the next day it seems to be something new." Okojie, et al., (2006) would
agree with this statement: "The decision on the selection and use of technology for instruction should be made at the onset, when the instruction is being prepared" (p. 66). Participant 210V identified awareness time to mean preparing for the lesson: "I do not always have the time to utilize technology to its fullest capacity, due to time constraints as well as the lack of formal training."

Eight out of the 10 teachers participating in this study rely solely upon district administered professional development to provide them with the awareness and operation of new technologies. Only Participants (207N) and (203N) identified other locations for discovering new technologies to use in the teaching and learning environment. Here we begin to see a divide between the veteran and novice groups. The quotes cited in the above paragraph are from veteran participants, with the two participants identifying other locations for professional development being novice. There seems to be a reluctance by veteran participants to invest the time to seek out new and better ways of delivering instructional content to students. As this researcher was casually talking to one of the participants about this idea of time and its different aspects, he stated: "If it's not broke, why fix it? What I do in my classroom is no different than someone else using a smart board. It's the same thing, just different format" (204V).

While the first step to fully integrating technology in classrooms is to create time to become aware of new and different technologies and tools to help students, the next step is to find time to learn what the technology can do. Teachers can then understand the potential value that a particular technology can offer to enhance and innovate a lesson. Part of this perception involves evaluating functionality, short-cuts, and ease of use. Instructors could get overwhelmed with frustration or classroom management issues if they rush into application without properly vetting functionality and operational issues beforehand.
Time to Learn

Time to learn is the time required to learn the operation of and functionality of a new technology (Butler & Sellbom, 2002). In his open-ended response, Participant 210V states, "I do not always have the time to utilize technology to its fullest capacity, due to time constraints as well as the lack of formal training." This sentiment was also expressed by 305V who states, "I just don't feel like I have the time myself to fully explore the options and operations and be ready to present a strong lesson on any kind of new technology."

210V recalls a professional development session and states, "while I had a chance to view the processes and even mimic processes that were shown to me, so much was disseminated in such a short period of time (that) it was impossible to grasp and retain all that was shown to me. The technology is exciting, but not being able to use it to its fullest potential due to a lack of training is extremely frustrating."

210V goes on to identify this "time to utilize technology to its fullest capacity" in terms of comfort level. This teacher goes on to say: "I have to feel comfortable with being able to move through the technology so that I am not fumbling and wasting valuable class time." This view concurs with Topper’s (2004) work, which states "for teachers to use technology in support of their teaching, and see it as a pedagogically useful tool, they must be confident and competent with the technology they are planning to use" (p. 304). Donovan et al. (2014), would also concur stating “With the advances and importance of technology, and the rapid changes in technology tools, it is important to exhibit functional use…Naturally, it is the teacher’s responsibility to provide for these experiences” (p. 163).

Their responses would indicate that novice participants are more willing to "fool around" with technology this kind of time investment would indicate a greater value than for the veteran participants. Time must be invested in the operation-- the "hands-on" experience--which teachers
obtain from a professional development session. Data from this study has shown that some veteran participants are entering these sessions with a "why fix what is not broken?" attitude. Providing a sense of comfort, as well as sensitivity to improving standard instructional delivery methods, might help to ensure that the implementation of new technologies is given a fair chance to take hold.

**Time to Apply**

Beyond spending time to learn about both operation and awareness of a technology, the next step is application in the teaching and learning environment. This dynamic environment can present many different challenges both in grade level and class period. The time investments spent in awareness and operation will now be tested when applied to these different settings. A teacher’s ability to correctly predict which technology will or will not work in different classroom settings will reflect such preparedness. One must also consider that the greatest unforeseen force in this case might be the resistance to change.

The next aspect of time that was identified in this study, was the time needed to incorporate the new-found technology into classroom activities. This is the time required to apply the newly found, newly learned technology into the curriculum of the teaching and learning environment. The application of technology in this manner will require a creative understanding of what the technology can do, and how it might best benefit the students that engage with it. This application time, may also manifest itself as the "use" of the technology in a learning unit or lesson activity. This idea is supported by the work of Greenhow, et al., (2008) who stated that "skillful teaching is demanding and integrating technology into teaching and learning places additional demands on teachers...." (p. 9).
The demands of which they speak are seen in the concerns of Participant 307N, who states, "How difficult will it be for the students to use it? and Do I have enough time to train the students?" The ease of use that 307N speaks of refers to the ease with which a user learns the operation of and functionality of a new technology. The perception of ease of use is dependent upon the speed at which one can process the intuitive nature of the technology. Participant 209N believes that "ease of use is very important for both the educator and the student. If the technology is easy to use, then I think it helps the students to be able to learn with it." Participant 213V has similar concerns as 307N, stating, "What students are in the class and whether they can use the technology appropriately and how much I will have to explain to the class."

Here we find the concern of novice participants with ease of use, and their enthusiasm to quickly implement this new technology. TPACK questionnaire items such as, "I am thinking critically about how to use technology in my classroom" (#37), "I can adapt the use of technologies that I am learning about to different teaching activities" (#38), and "I can select technologies to use in my classroom that enhance what I teach, how I teach and what students learn" (#39), point directly to technologies application. Data from this study revealed an average response difference between veteran and novice participants for each of these questions to be (1.6), (1.8) and (1.4) respectively. This would indicate that novice participants in this study feel better equipped in the application of a new technology, compared to those of veteran participants. It would seem that novice participants are more willing to consider the time investment of a new technology because of the benefit that it would provide their students.

As one shifts from the application of technology in the classroom to its repeated use, concerns surrounding availability of resources and technical support begin to emerge. The one-time application of a new technology does not provide enough feedback to justify its dismissal.
from use. One must persist in his or her beliefs and perceptions surrounding a technology’s benefit. Only through multiple applications and assessments, with similar results, can one choose to accept or reject a technology’s use. The utilization of a technology in the classroom environment is directly related to the frequency of use. How often, and to what degree, is a technological resource being used in the teaching and learning environment? The repetitive use of a technology is what separates application from utilization, and without proper time investment in both resources and support all would seem for naught.

**Time to Utilize**

The final section concerning time will consider point (c) from the Hora and Holden (2013) research study: the actual classroom uses of the technology. This section will consider how often the new technology is being used, and the level at which its benefits are being realized. This category of time must also take into account the availability of resources, since the time needed to utilize the technology would seem to be dependent upon its availability. The availability of the technological resource will greatly impact the frequency of use, as well as decrease the time needed to find the optimal benefits of its use for the students. This study revealed that the utilization of technology by both veteran and novice participants was about equal.

Ertmer (1999) identifies first-order barriers as being extrinsic to educators and may include such problems as a "lack of access to program software and desktop access" (p. 156). This first-order barrier concerning lack of access was also identified in this study. Participant 206V states that one of the most frustrating aspects of using technology in the classroom is the lack of individual computers and the out-datedness of the equipment. This sentiment is also felt by 203N who cites "not having resources, no computer cart, and I need a set of chrome books for
classroom group work" as challenges as well. 207N states, "It really all depends upon whether or not I can get access to the technology. I would use them more if I didn't have to worry about sharing". 203N feels that when considering the use or disuse of technology in the classroom, availability is one of the contributing factors.

When one considers the word frequency of the open-ended survey, data shows that "computers" (10 occurrences) was reported by novice participants. This was reported just as often as veteran participants and their concerns for "time." Participants 203N and 207N state how the availability of resources has hindered their utilization. Attempting to implement a new technology into the teaching and learning environment with a limited availability can prove to be very difficult for both veteran and novice teachers. Novice participants seem to be concerned with the lack of available resources, but yet have a frequency of use as a group; slightly higher than that of veteran participants. Novice participants also perceive their technology use to being about once per week, even with a reported higher frequency. The concerns that the novice participants have surrounding the idea of implementing new technologies in the teaching and learning environment display a need for new approaches to the design of technology-focused professional development.

Support

Another aspect to consider is the support needed by both the student and the teacher to ensure a successful transition from a prior method. For the purpose of this study, “support” will be defined as the reinforcing/reviewing knowledge needed when unanticipated problems arise. One of the additional first-order barriers identified by Ertmer (1999) in her study is "insufficient technical and administrative support" (Mistler-Jackson & Songer, 2000 and Fletcher, 2006). Likewise, Greenhow, et al., (2008) spoke of the added demands that technology integration
places on teachers; they concluded that these added demands could be eased through the establishment of an adequate support system. Participant 308N describes this challenge in her own classroom by stating, "When students need tech support, it really slows things down.... I often ask students for help." 305V points out that there is no support: "We don't have a technology teacher in the building who can put a program in place and bring students up to speed." 307N feels that the most frustrating aspect of using technology is "when the internet is down, or an application is not working properly." 207N feels the same frustration: "I feel less equipped to help students when they are having problems." This lack of a support system could contribute to teachers taking fewer risks when trying new technologies, the fear of failure, or even the wasting of valuable class time.

**Summary**

In general, the findings of this study have revealed some interesting perspectives regarding the improvement of professional development for teachers that focuses on incorporating technology into the classroom. Veteran participants displayed a reluctance to change, providing statements concerning investing time into new pedagogical practices when they consider their current practices to be sound. School administrators must be sensitive to these concerns when providing professional development on new technologies. On the other hand, novice participants – who as a group were more open to incorporating technology into pedagogical practices -- need to be afforded an opportunity to explore other emerging methods for technology implementation. This exploration could take the form of conferences, webinars, or possibly leading professional development sessions, which would allow them to express the benefits of their new technological discoveries.
Veteran participants need to be given the time to properly explore the functionality of a new technology. These individuals need to feel comfortable working with this new tool and be provided the time to thoroughly assess the new technologies benefits to students. Additional professional development time may be needed to accomplish this task. Novice participants need to have emphasis placed on the benefit of investment. The "ease of use" factor provides novice participants with an understanding of time investment versus benefit to the student. A successful professional development will stress this point and possibly overcome the reluctance to change factor found in veteran participants.

Technology utilization and access are critical to the implementation of new technologies. The analysis of frequency and use in this study found only a slight increase by novice participants in frequency, and an equal use by all. The perceptions derived from this study concerning frequency of use, and the need for more available resources, only serve to underscore the importance of improving aspects of professional development design.
Chapter 5: Conclusions and Recommendations

Introduction

Technology’s impact on the teaching and learning environment has changed not only the way our students process new concepts and achieve learning objectives, but it has also modified the way in which instruction is delivered. The educational technologies that a teacher may use in the teaching and learning environment do not adapt to every diverse need; rather, it is the job of the teacher to creatively apply these tools to meet those needs in innovative ways. The purpose of this study is to understand the range of ways in which the teacher participants adapt and incorporate technology into their teaching and learning environment and how individuals may experience barriers in doing so.

To that end, this study compares teachers' technology use across characteristics such as years of experience in teaching while also examining teachers’ perceptions about the level of technology integration. The results are intended to add to the current understanding of how educators utilize technology in the classroom and how its innovative use in turn informs the kinds of support schools provide, not only to the individual teachers, but also on a school wide-basis. This study employed an embedded mixed methods approach consisting of the examination of archival lesson plans, an open-ended survey, and the TPACK questionnaire with appropriate coding and analysis of each.

In general, veteran participants displayed a reluctance to incorporate technology into their classrooms, expressing concern around time investments into new pedagogical practices when they considered their current practices sound. Novice participants in general noted the need to be provided an opportunity to explore other avenues for technology implementation, such as time to become aware of different possibilities, while veteran participants expressed the need to be given
the time to properly explore the functionality of a new technology. Both the veteran and novice participants of this study agreed that more support is needed for when technological issues arise, as well as the need for more resources to be utilized in the teaching and learning environment.

**Site Ecology**

The ecology of the study site is very friendly, most staff members are friends with one another and gather after school hours to socialize. Participants in this study share successful teaching strategies with one another on a regular basis. When a new teaching strategy involving technology emerges it seems to spread like wild fire around the building. For example, a year before this study was conducted Kahoot was introduced to the building. Students found this new technology so innovative that every teacher in the building was using it by weeks end. This particular case seemed to be student driven, almost forcing reluctant individuals into the adoption of this new technology.

Students embraced the interactivity of the new web tool and for the first time were allowed to use their cell phones in classroom activities. Kahoot allowed for students to participate in the lesson and not feel intimidated to answer a question for fear of an incorrect answer. They no longer had to sit idle and wait for their turn to participate. At first, all the teachers used Kahoot the same way to review a concept or test prep. But, as this web tool evolved teachers began creating their own and using it to not only prep students for classroom tests, but the Keystone exams as well. Other teachers had the students develop their own Kahoot’s centered around a topic of interest.

A more recent case involved the introduction of digital notebooks by an individual teacher. He was observed in hall ways and classrooms showing other teachers the benefits of incorporating these digital notebooks into their curriculum. The follow professional development
session, he again addressed the entire staff about his use of this technology and discussed ways that it could help improve academic outcomes in other classes. Students were observed using these digital notebooks in other classes, but the teachers were not observed encouraging its use. The building administrator, who is also tech-centric, is very transparent in the way teachers present their subject matter. He encourages the use of technology but does not require teachers to utilize it in every lesson.

Technology utilization and access are critical to the implementation of new technologies. The analysis of frequency and use in this study found only a slight difference between the participating groups in frequency. The perceptions derived from this, concerning frequency of use, and the need for more available resources, only points to the concerns of improving aspects of professional development design.

**Conclusions**

This study looked to answer the following research questions:

1. What patterns can be seen in the ways teachers adapt technologies to their current teaching and learning environment?

2. What relationship exists between a teacher's TPACK score and their perceived use of technology in their current teaching and learning environment?

3. How can one characterize teachers' decisions about technology use when viewed through the TPACK framework?

Each of the above questions will be addressed individually in the following sections:
What patterns can be seen in the ways teachers adapt technologies to their current teaching and learning environment?

When examining patterns in the way teachers adapt technologies to their teaching and learning environment, this study found little or no difference between veteran and novice teachers. The archival lesson plan analysis revealed that both groups documented evidence of "High" and "Low" degrees of technology integration. For the purpose of this study "High" is defined as a classroom activity that would require interaction between a student and a computer program, that can be adaptive, and requires the student to provide input. "Low" is defined as a classroom activity that does not require student interaction with a computer or software program. Examples of each can be found in Chapter 4 (See Table 3) of this study. Both veteran and novice participants demonstrated a similar frequency of "High" and "Low" integration techniques.

Analysis of open-ended survey revealed differences between veteran and novice participants. When the survey responses of each participant (and then group) were examined for frequency of word use, the perceptions on the use of technology began to emerge. Both the veteran and novice participant results had similar frequencies for the words "Students" and "Technology" and were the highest for each group. Further analysis demonstrated that veteran participants referred to "Time" and "Notes" as the third and fourth most frequent word, while novice participants referred to "Classroom" and "Computer" as the two next most frequent.

The results of this study would suggest that novice participants perceive technology as a vital component in the teaching and learning environment (Classroom). This would also suggest that novice participants perceive computers as a critical piece of the learning process. Veteran participant responses suggested a quite different perception. The results suggested that veteran participants perceived technology integration as time consuming and would aid in the note taking
process. These general summations of veteran and novice perceptions speak directly to the idea of innovation. Innovation or design thinking, considers what is done with the technology at hand. Novice participants perceive computers as a critical piece of the learning process, because they understand the value of having technological options when attempting to problem-solve or think critically. Veteran participants on the other hand, may find innovative ideas time consuming and still want to hold on to the “If it isn’t broke, why fix it” mentality.

These differences in perception might stem from one's own level of formal/informal training and experience. Why are veteran participants so hung up on time? What training or experiences have lead novice participants to place a higher value on technology use? At what point will novice perceptions concerning technology use, begin to reflect the perceptions of veteran participants? Can the perceived value of technology use in the teaching and learning environment seen by novice participants, influence the perceptions of veteran participants?

**What relationship exists between a teacher's TPACK score and their perceived use of technology in their current teaching and learning environment?**

When examining the relationship between a participant's TPACK score and their perceived use of technology, differences between veteran and novice participants emerged. The analysis that compared veteran and novice participants based solely on the entire TPACK score revealed little or no difference (0.2). Further analysis into the seven sub-divisions of the TPACK questionnaire revealed unique differences. When these differences are compared to word frequencies, as discussed above, a clearer picture of perception difference begins to emerge.

There were three sub-sections of the TPACK questionnaire that revealed differences between veteran and novice participants. These sub-sections are Technological Knowledge (TK) (questions 1-6), Pedagogical Content Knowledge (PCK) (questions 26-29), and Technological
Pedagogical Knowledge (TPK) (questions 34-42). Novice participants were found to report a greater score in TK, with a difference of (1), and TPK with a difference of (0.8). Veteran participants reported a greater score in PCK, with a difference of (0.8). This would suggest that novice participants keep up with new technologies and possess a wide range of different technologies that would best fit the method of instructional delivery. This would also indicate a larger “technology took kit” from which to generate innovative thinking. The data also points to veteran participants possessing a greater understanding of what, when, why, and how to teach specific content. Suggesting that veteran participants possess the ability to think innovatively but lack the scaffolding from which to build upon. Mishra & Koehler, (2006) define PCK as, “It represents the blending of content and pedagogy into an understanding of how particular topics, problems, or issues are organized” (p.1021).

This would suggest that novice participants possess a more extensive "technology tool kit" compared to that of veteran participants. For the purpose of this study, a “technology tool kit” will be defined as a collective of different known technologies that a teacher may use to generate innovative ideas or outcomes. This would also suggest that veteran participants did not have access to formal technology training. A third piece to consider is a person's comfort level when it comes to adapting and changing. Veteran teachers may have grown used to using a piece of technology a certain way and have begun to refine creative pedagogical uses for it. Novice teachers on the other hand, may still be looking for the technologies that best suit their style of teaching and look to diversify their technology tool kit.

With a heavy dependence upon professional development by many districts, are we providing adequate learning time for teachers when it comes to the use of technology? Are current professional developments considering the comfort ability that teachers have operating
the functions of a new technology? TPACK questionnaire items such as, "I can learn technology easily" (#2), and "I frequently play around with the technology" (#4), point directly to this idea.

**How can one characterize teachers' decisions about technology use when viewed through the TPACK framework?**

When examining this relationship, the results from this study pointed to differences in Technological Knowledge (TK), Pedagogical Content Knowledge (PCK) and Technological Content Knowledge (TCK). Novice participants in this study reported greater averages in TK and TCK, with veteran participants reporting a greater PCK average. These findings are supported by the results of a study conducted by Qingtang Liu, Si Zhang, and Qiyun Wang (2015), which state that "In the TK variable, in-service K-12 teachers with 1 to 5 years of teaching experience scored significantly higher than those with 11 to 20 years and above" (p. 65). Similar to this study with novice participants having 1-8 years of experience and veteran participants having 9-20 years. This study and the one mentioned above would indicate the hesitance of technology use on the part of the veteran participants. In particular, their perception of time to develop innovative approaches to existing pedagogy. The presence of this hesitance was also seen by veteran participants in their open-ended responses, 305V states, "There's no support. I might have a problem bringing it all in at the same time, since some kids would need more technical help than others." 210V states, "I do not always have the time to utilize technology to its fullest capacity, due to time constraints as well as the lack of formal training.”

The hesitance felt by veteran participants in utilizing technology in the teaching and learning environment may stem from a fear of change or fear of innovation. The lack of adequate support and the time investment necessary to incorporate different technologies into various lessons would be perceived as a great shift from the pedagogical ideologies that have proven
successful in the past. Barriers such as awareness, lack of time to learn and implement, as well as a lack of resources would deter a veteran participant from pursuing this type of technological integration.

**Recommendations**

This study examined the way ten teachers utilize technology in their lesson planning and classroom activities for variety and frequency. Additionally, comparisons were made between years of experience, with consideration of the amount of formal and informal technology training received. These factors may or may not directly impact the extent and depth of technology integration but could provide some context to the impactful nature that technology possesses.

The purpose of this study was to inform and improve technology professional development for teachers. Based on the findings of this study, it is recommended that teachers, building administrators and district administrators consider perceptions of a variety of different factors that influence the integration of technology into the teaching and learning environment as they plan for the use of technology in their schools and the associated training and support for teachers.

In order for teachers to have an active voice in the integration of technology, they must first consider the most frustrating aspect of technology use. Examples of barriers included, but were not limited to, the lack of support when issues arise and the lack of investment in time necessary to successfully incorporate a new technology or method. These perceived barriers of time and support are considered First-Order and seen in most of the veteran participants of this study. The novice participants considered lack of available resources and adequate support to be the most difficult barriers to deal with. When teachers are aware of the barriers that they perceive to be limiting their use of technology, if communicated to those in charge of professional
learning in the schools, this information can be used strategically to design supportive and potentially ongoing leaning opportunities for teachers.

In order for building administrators to help foster the development of technology integration into the teaching and learning environment, this study revealed that lesson plans are a useful source of information on the frequency of use of planned technology in a lesson. Building administrators could pay close attention to lesson plans to assess how often and to what degree teachers are using technology to promote innovation. Coupled with observations, this information can be used to design differentiated professional development for teachers in a school and in doing so, might take advantage of teachers in a school who can act as a resource to promote and encourage innovative techniques.

For the district level administrators and technology directors, they should consider items such as infrastructure, availability and age of equipment. Are district school buildings equipped with sufficient band width and internet speed to meet the demands of teachers and students? One might also consider the technology needs of both teachers and students, as well as the age and availability of the equipment being used. Finally, district administrators and technology directors should provide teachers with professional development sessions that expose them to new and different technologies that generate innovative ideas, allowing teachers to increase their “technology tool kits” and evaluate the incorporation of these technologies for their unique settings.

One of the barriers to technology integration is a lack of awareness. This study defined technology integration as: only being achieved when students are able to select technology tools that will help them obtain information, analyze it and synthesize that information for future use (NCES, 2008). Some participants in this study expressed their lack of time needed to search out
technologies to improve innovative techniques in the teaching and learning environment. By providing teachers with the exposure to different ways of integrating technology and increasing the variety of tools available to them, one will begin to fit the definition of true technology integration, and innovation as teachers model this behavior for students. Without the exposure, support and professional development sessions of teachers to a variety of different technologies, students will only have a limited choice of technology tools to synthesize information.

**Study Improvements**

One of the limitations of this study was sample size. An increased sample size would allow for the analysis of a larger data set and thus more statistically sound research findings. That expanded data sample would also cut across school buildings to learn about variations across schools. With a larger sample size, future research would also utilize selective follow-up interviews with participants. This would allow for a deeper understanding of a participant’s perception of technology barriers and use the TPACK framework to help explain these differences.

Walk-through observations of participants in their teaching and learning environment would also enhance the data collection and inform the validity of the lesson plan analysis. This would allow the researcher to confirm the frequency and variety of use reported by participants. This study did not provide the time or the ability for this researcher to incorporate this type of data collection.

This study found that veteran participants are more likely to rely on time tested pedagogical methods and view the integration of technology as time consuming. Novice participants, who may lack the pedagogical background of veteran participants, embrace the value of a variety of technological tools and find them critical to the teaching and learning
environment. Future research would allow us to confirm this conclusion across a larger population.

Summary

The transformative nature of educational technologies has profoundly changed pedagogical thinking and looks to revolutionize our educational system and the instructional technology choices that educators make. Technology use is not as simple as one might think. There are a multitude of barriers that can prevent technology integration from happening. As time passes and new instructional technologies evolve, so will the ideas of innovating academic understanding in unconventional formats. Understanding the existing technologies and potential barriers, as well as how teachers experience those barriers, is going to be critical to successful integration, innovation and adaptation over time.

The perceptions of technology’s impact on the teaching and learning environment can be different for each individual and subsequently affect the extent of its integration. However, integration is not simply about the technology choice itself, but rather, the innovative way a teacher utilizes the technology. In order for true integration to occur, one must make careful technological choices in light of pedagogical goals and available options. Educators are encouraged to look at technology as an innovative tool used to assemble new ideas, in new ways, providing new approaches to old problems.

References


Appendix A: TPACK Questionnaire

The questionnaire to be utilized was created to assess the effectiveness of the TPACK framework's application by the creators of the TPACK framework itself. The validity of the questionnaire has been tested by numerous research studies, has withstood scrutiny and for the purpose of this study will be applies as a source of measurement and data collection. The questionnaire to be applied is as follows:

*Technology is a broad concept that can mean a lot of different things. For the purpose of this questionnaire, technology is referring to digital technology/technologies. That is, the digital tools we use such as computers, laptops, iPods, handhelds, interactive whiteboards, software programs, etc. Please answer all of the questions and if you are uncertain of or neutral about your response you may always select "Neither Agree or Disagree"*

<table>
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<tr>
<th>General Technology</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neither Agree or Disagree</th>
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<tbody>
<tr>
<td>1. I know how to solve my own technical problems.</td>
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<td>2. I can learn technology easily.</td>
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<td>3. I keep up with important new technologies.</td>
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<td>4. I frequently play around the technology.</td>
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<td>5. I know about a lot of different technologies.</td>
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<td>6. I have the technical skills I need to use technology.</td>
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<td>7. I have sufficient knowledge about mathematics.</td>
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<td>8. I can use a mathematical way of thinking.</td>
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<td>9. I have various ways and strategies of developing my understanding of mathematics.</td>
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<td>Social Studies</td>
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<td>10. I have sufficient knowledge about social studies.</td>
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<td>11. I can use a historical way of thinking.</td>
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<td>12. I have various ways and strategies of developing my understanding of social studies.</td>
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<th>Neither Agree or Disagree</th>
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<td>13. I have sufficient knowledge about science.</td>
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<td>14. I can use a scientific way of thinking.</td>
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<td>15. I have various ways and strategies of developing my understanding of science.</td>
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<th>Literacy</th>
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<td>16. I have sufficient knowledge about literacy.</td>
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<td>17. I can use a literary way of thinking.</td>
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<td>18. I have various ways and strategies of developing my understanding of literacy.</td>
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<tr>
<th>TPACK</th>
<th>Strongly Disagree</th>
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<th>Neither Agree or Disagree</th>
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<td>19. I know how to assess student performance in a classroom.</td>
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<td>20. I can adapt my teaching based-upon what students currently understand or do not understand.</td>
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<td>21. I can adapt my teaching style to different learners.</td>
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<td>22. I can assess student learning in multiple ways.</td>
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<td>23. I can use a wide range of teaching approaches in a classroom setting.</td>
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24. I am familiar with common student understandings and misconceptions.  

25. I know how to organize and maintain classroom management.  

26. I can select effective teaching approaches to guide student thinking and learning in mathematics.  

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<th>TPACK</th>
<th>Strongly Disagree</th>
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<th>Neither Agree or Disagree</th>
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27. I can select effective teaching approaches to guide student thinking and learning in literacy.  

28. I can select effective teaching approaches to guide student thinking and learning in science.  

29. I can select effective teaching approaches to guide student thinking and learning in social studies.  

30. I know about technologies that I can use for understanding and doing mathematics.  

31. I know about technologies that I can use for understanding and doing literacy.  

32. I know about technologies that I can use for understanding and doing science.  

33. I know about technologies that I can use for understanding and doing social studies.  

34. I can choose technologies that enhance the teaching approaches for a lesson.  

35. I can choose technologies that enhance students' learning for a lesson.  

36. My teacher education program has caused me to think more deeply about how technology
could influence the teaching approaches I use in my classroom.

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<th></th>
<th>Strongly Disagree</th>
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<th>Neither Agree or Disagree</th>
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<tr>
<td>37.</td>
<td>I am thinking critically about how to use technology in my classroom.</td>
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<td>38.</td>
<td>I can adapt the use of the technologies that I am learning about to different teaching activities.</td>
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<td>39.</td>
<td>I can select technologies to use in my classroom that enhance what I teach, how I teach and what students learn.</td>
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<td>40.</td>
<td>I can use strategies that combine content, technologies and teaching approaches that I learned about in my coursework in my classroom.</td>
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<td>41.</td>
<td>I can provide leadership in helping others to coordinate the use of content, technologies and teaching approaches at my school and/or district.</td>
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<td>42.</td>
<td>I can choose technologies that enhance the content for a lesson.</td>
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<td>43.</td>
<td>I can teach lessons that appropriately combine mathematics, technologies and teaching approaches.</td>
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<td>44.</td>
<td>I can teach lessons that appropriately combine literacy, technologies and teaching approaches.</td>
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<td>45.</td>
<td>I can teach lessons that appropriately combine science, technologies and teaching approaches.</td>
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<td>46.</td>
<td>I can teach lessons that appropriately combine social studies, technologies and teaching approaches.</td>
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Appendix B: Studies Related to TPACK Questionnaire

The following papers and presentations highlight the development process of this questionnaire:


*Examining preservice teachers’ development of technological pedagogical content knowledge in an introductory instructional technology course.* Paper presented at the 2009 International Conference of the Society for the Information and Technology & Teacher Education. March 2-6, Charleston, SC.

Changing technological pedagogical content knowledge (TPACK) through course experiences. Paper presented at the 2009 International Conference of the Society for the
In the papers cited above, the categories in the questionnaire were removed so that participants were not oriented to the constructs when answering the questions. The items were presented in order from 1 through 46, however. The other items are more particular to individual study and teacher education context to better understand results found on questions 1-46.
## Appendix C: Example of Lesson Plan Format

**Participating Teacher**  
**Room XXX**  
**Anatomy and Physiology**  
**Dec. 9-13**

### Pennsylvania Common Core Standards

- **8.6**: Writing arguments focused on discipline-specific content
- **3.5**: Reading Informational Text
- **2.4**: Data Analysis and Probability

### Materials:

- E-Z Anatomy and Physiology textbook and resources, 2004
- Internet resources related to science concepts

### Standards

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<tr>
<th>Standards</th>
<th>Explain the relationship between structure and function at all levels of organization.</th>
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<th>Monday</th>
<th>Skeletal System: Bones of the vertebral column part 1, Page 22.</th>
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<td><strong>Objective: SWBAT:</strong></td>
<td>describe the general structure of the vertebral column and name its components, indicate a common function of the spinal curvatures and the intervertebral discs, and discuss the structure of a typical vertebra and then describe the special characteristics of cervical, thoracic, and lumbar. <strong>IOT:</strong> properly identify the slight differences between the different vertebra and relate the form of each vertebra to their overall function within the human body. <strong>Class Activities:</strong> Students will be instructed to get into groups and place the properly labeled pieces of tape onto a thoracic vertebra. <strong>Assessment:</strong> The instructor will circulate throughout the classroom checking for student understanding by assessing student progress on the day’s activities and asking critical thinking questions. <strong>Homework:</strong> Create a posterior view of a thoracic vertebra, labeled appropriately to what was learned so far.</td>
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<th>Tuesday</th>
<th>Skeletal System: Bones of the vertebral column part 2, Page 22.</th>
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<td><strong>Objective: SWBAT:</strong></td>
<td>describe the general structure of the vertebral column and name its components and discuss the structure of a typical vertebra and then describe the special characteristics of cervical, thoracic, and lumbar vertebrae. <strong>IOT:</strong> relate a vertebra's unique shape to its overall function within the human spine. <strong>Class Activities:</strong> Students will be instructed to create an alternative vertebral column using the following materials: tong</td>
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depressors, glue, cotton balls, paper, resource manuals, and string. The concept model will be required to balance the weight of a biology textbook. **Assessment:** The instructor will circulate throughout the classroom checking for student understanding by assessing student progress on the day’s activities and asking critical thinking questions. **Homework:** Create a posterior view of a cervical vertebra, labeled appropriately to what was learned so far.

**Wednesday**  
Skeletal System: Bones of the vertebral column part 3, Page 23.  

**Objective: SWBAT:** describe the relationship of the hyoid bone to the vertebral column and identify the regions and normal curves of the vertebral column and describe its structural and functional features. **IOT:** identify the regions within the back which each curvature can be found and distinguish between a normal curvature and one that is not normal.  

**Class Activities:** Students will be instructed to finish constructing their theoretical vertebral columns. Students will also test their columns to determine success. **Assessment:** The instructor will circulate throughout the classroom checking for student understanding by assessing student progress on the day’s activities and asking critical thinking questions. **Homework:** Create a posterior view of a Lumbar vertebra, labeled appropriately to what was learned so far.

**Thursday**  
Skeletal System: Bones of the vertebral column, Page 22-23.  

**Objective: SWBAT:** describe the general structure of the vertebral column and name its components and discuss the structure of a typical vertebra and then describe the special characteristics of cervical, thoracic, and lumbar vertebrae. **IOT:** identify each human vertebra by shape and to use the proper terminology when discussing said vertebra. **Class Activities:** Students will be instructed to observe the vertebral column of a white tail deer. A recently killed deer skeleton was brought in to reinforce and review for the exam. **Assessment:** The instructor will circulate throughout the classroom checking for student understanding by assessing student progress on the day’s activities and asking critical thinking questions. **Homework:** Study for exam.

**Friday**  
HOUSE: Dammed If You Do, **HW:** Students are to complete a “house paper”, this is to be typed and submitted the next school day. A copy of a completed “house paper” is attached. **Activities:** Students will view an episode of “HOUSE”, which applies to the topics covered in class during
the past week, while completing a provided “Medical Chart”. A copy of this “Medical Chart” is also attached. **Assessment:** The instructor will check for student understanding by correcting student mistakes found within the “house paper”.

- Students will be able to name and draw binary inorganic covalent compounds by using prefixes, roots, and suffixes
- Students will be able to explain the workings of some common medical tests, their need, and provide basic knowledge behind the appropriate medication needed to the patient in question.
Appendix D: Open Ended Survey Questions:

1. For how many years have you been a classroom teacher? (Cumulative Years)
   Answer:

2. Which of the following disciplines do you primarily teach (Math, Science, English, Social Studies or Other)? Please select your choice based on the greatest number of years in that discipline.
   Answer:

3. Can you describe what you think successful technology integration looks like in the classroom?
   Answer:

4. Can you describe how you learned to use technology both personally and in your classroom?
   Answer:

5. In what ways have you (or do you) learn about new technologies for the classroom? (Blog, Professional Development (PD), Friend, Conference)
   Answer:

6. When you plan a unit of study, how often, and to what extent do you utilizing technology as part of your lesson?
   Answer:

7. Recalling a lesson taught with technology, please describe the context/topic, technology used, and the desired outcomes for students with this lesson.
   Answer:
8. Describe how the technology training that you received (both formal through Professional Development/Workshops/Trainings and informal through other means) has translated to use of technology in your classroom. Please share an example of something from your own classroom.

Answer:

9. What do you feel is the most frustrating aspect of using technology in your classroom?

Answer:

10. Recalling a technology training that you participated in, please describe the context of the training and how it "Did" or "Did not" enhance technology use in the classroom environment (either formal through Professional Development or informal through other means).

Answer:

11. When considering the use of (or not using) technology in your classroom, what factors influence your decision?

Answer:
APPENDIX E: LETTER OF RECRUITMENT

Dear Faculty Member,

This letter is an invitation to participate in a Drexel University research study concerning the integration of technology in the teaching and learning environment. You have been selected to complete both a questionnaire and a few open-ended questions, because you were teaching with technology in the 2015-2016 school year.

Participation in this study is voluntary and at any time during the study you may choose to withdraw. If you decide to participate, an email containing both a questionnaire and a set of open-ended questions will be sent to you using the email address you provide below. Completion of the two items is estimated to take about 30 minutes in total. In addition, you will grant the researcher permission to analyze about 10 lesson plans for technology integration. It is asked that you complete both of these documents electronically and email them back to me (mph76@drexel.edu) within a month's time of receiving them.

There are no foreseeable risks or discomforts associated with this research. In fact, you may find the responses to some of the questions to be enjoyable. By participating in this research, you may benefit other teachers by helping them and educational leaders better understand perceptions surrounding technology integration in the classroom.

Several steps will be taken to protect your anonymity and identity. While the responses to both the questionnaire and open-ended survey will have come from your email account, the transcribed results will not contain your name or any identifying information. Additionally, all information will be held confidentially. The data will be stored in an encrypted, password-protected computer at Drexel University, and is only accessible by the researcher.

The results of this study may be published in education journals and presented at educational conferences. If desired, you may access the results of the study through the building administrator, or the autonomy network's assistant superintendent office. If you require any additional information about this study and would like to speak with the researcher, please call Michael Hardisky at (215-260-1939).

I have read the above information regarding this study on the integration of technology in the classroom and accept the invitation to participate.

Name Printed: ________________________________

Preferred Email Address: ________________________________

Signature: ________________________________ Date: ________________