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# Interactive Whiteboard Transition: A Case Study

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To the Graduate Council:

I am submitting herewith a dissertation written by Jason S Beach entitled "Interactive Whiteboard Transition: A Case Study." I have examined the final electronic copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Education.

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# Interactive Whiteboard Transition: A Case Study

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## Dedication

The completion of the project would not have been possible without the love and support of my family. Natalie, I cannot express in words how deeply thankful I am to have you in my life. Without your support and encouragement I would have not been able to complete this project. Thank you for the late night edits and understanding the stress I was going through. To my dad and mom, without your encouragement and support I would not have made it to this point. Thank you for instilling in me the importance of life-long education and pushing me not to settle, but to strive for perfection.

This dissertation and all of the sacrifices and hard work that it represents are dedicated to my family and future generations. It is my hope that this accomplishment will encourage others to achieve the perceived impossible, and always do their best no matter what they do in life.

*Gloria Patri, et Filio, et Spiritui Sancto. Sicut erat in principio, et nunc, et semper, et in sæcula sæculorum. Amen.*

## Acknowledgments

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## Abstract

This case study examined the process teachers use when incorporating interactive whiteboards in the classroom and daily curriculum. Participants were drawn from a small group of three elementary and three high school teachers who received an interactive whiteboard, but no formal training. The school system purchased over 300 interactive whiteboards and was not able to adequately train all of the teachers before the beginning of the school year. Findings were compared to relevant models of andragogy, TPACK, and CBAM. The results indicate that a teacher's prior technological ability aids in the implementation of new technologies in the classroom. The findings also indicate the importance of peer-support and proximity when dealing with technical difficulties. There is an apparent need for a technology-specific adoption model that utilizes the technical experience teachers bring with them when they enter the classroom. The researcher introduces a working model for this process.

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# Chapter 1

## Introduction to the Study

Past technologies such as chalkboards, mass-produced textbooks, and bound notebooks have had a dramatic impact on the way teachers deliver textual information to students in the United States. Later, the addition of pull-down maps, overhead projectors, filmstrip projectors, and tape recorders and players changed the way students heard and visualized information in the classroom. As technology advanced, school systems introduced televisions, calculators, computers, VCRs, LaserDisks, and most recently, interactive whiteboards to the classroom. Advances in technology have impacted the way information is disseminated and have affected the way teachers educate schoolchildren in the United States. With each technological advancement, teachers have been given new tools that can be used to teach and deliver content in the classroom.

Educational Technology is the study of improving performance and learning by creating, using, and managing the technological process and resources (Lowenthal & Wilson, 2010). Technologies that are incorporated into the classroom environment are referred to as instructional technologies. A critical component of the Educational Technology field is to learn about the effect technology can have on pedagogy and learning. This is important because the amount of instructional technology and teachable content that is available in the American curriculum is much greater today than ever before in the history of the nation (Parkerson & Parkerson, 2001).

**Legislation**

Not only has the amount of teachable content changed the way we teach our K-12 students, our use of instructional technology has changed the way we deliver content. The use of this instructional technology has changed the way we teach and learn and has also added a new level of complexity to the teaching process. To add to this complexity is the Enhancing Education Through Technology Program, a component of No Child Left Behind that specifically targets technology literacy for every student by the eighth grade ("Enhancing Education," 2001) and provides for the development of professional use of technology and technology funding opportunities for schools ("No Child," 2002). Each state defines what they consider to be technology literacy, ranging from integrated curricula within the academic classroom to specialized technology standards. Their definitions help to decide the degree to which they invest in technology and what specific materials and technologies they purchase.

No Child Left Behind is a renamed continuation of the Elementary and Secondary Education Act that was part of President Lyndon B. Johnson's War on Poverty initiative (U.S. Department Of Education, 2011). No Child Left Behind provides funding opportunities for professional development, instructional materials, educational support programs, and the promotion of parental involvement. In addition, Title I of Johnson's Elementary and Secondary Education Act allows supplementary funds to be distributed to schools in which 40% or more of the student population is classified as low-income, as defined by the U.S. Census. Recently, The American Recovery and Reinvestment Act of 2009 added an additional $650 Million to be used

for purchases of materials, including instructional technology in public schools (U.S. Department of Education Office of Elementary And Secondary Education, 2009).

**Distribution and Technologies**

Many school systems are using these funding opportunities to place interactive whiteboards into their classrooms, hoping to raise achievement scores (Halls & Higgins, 2005), address the learning needs of diverse populations (Latham, 2002), and enhance student technology skills (Kennewell, Tanner, Jones, & Beauchamp, 2008). Unfortunately, due to restrictions placed on funding opportunities and grants, these types of technology have not been equally distributed throughout school systems.

In some cases, a teacher can have a classroom filled with a fully interactive whiteboard, audio/video projector, interactive student response systems, and a wireless tablet that can be used to control the computer from across the room. The addition of this instructional technology allows the teacher to establish a student-centered teaching environment through the use of technology that allows students to interact and visually represent information in real-time. On the opposite end of the spectrum, some teachers have only an overhead projector with acetate slides, and the core of their instructional time is centered on teacher-driven paper and pencil activities (Peck, Cuban, & Kirkpatrick, 2002).

Not only is the presence of instructional technology in classrooms a highly variable factor, the ability of teachers to effectively utilize these technologies is equally variable by the fact that many teachers may not have received training in the pedagogical use of these devices. Instructional technologies like interactive whiteboards, wireless tablets, and interactive student

response systems, have only become prominent in the classroom within the last three to six years because of increased funding opportunities. Universities are only now beginning to train their preservice teachers how to implement interactive devices, software, and pedagogical techniques that can be used with interactive whiteboards to enrich the curriculum.

An interactive whiteboard is a solid board with a white, matte surface that looks very similar to a dry erase board. The board usually has an arm extending from it holding a digital projector that projects the image of the computer's desktop onto the matte surface. The teacher uses the large touch surface to interact with the computer and the interactive whiteboard software that comes with the device. An interactive whiteboard allows a teacher to manipulate text and images in real-time, as well as make annotated notes on projected content that can be viewed and saved for students to review later. With a large viewing surface, the interactive whiteboard provides a central location in the classroom for students to observe and interact with content. This allows the entire class to focus on a singular point and promotes student-centered group interactions.

An interactive whiteboard, in conjunction with its software, allows teachers to make fully interactive pages that can animate, display documents, link to websites, view movies, and allow annotation on documents and web pages. ActivInspire is the latest distribution of Promethean's interactive whiteboard software, and is available for computers using Windows®, Mac OS X, and Linux operating systems. Every interactive whiteboard comes with a fully enabled version of the interactive whiteboard software. Promethean's interactive software can also be used to gather

user-created files for the classroom, and it provides a training portal to the PrometheanPlanet website that teachers can use to learn the basic functions of the ActivInspire software.

While Promethean offers training opportunities through its website and software, it is generic in its application and not specifically focused on content delivery. There are two methods of training available; they include a free module and a paid module. The free training only offers information on the basics of the interface, and is only available through a Flash-based training module that is difficult to find within the PrometheanPlanet website. The free module only focuses on certain tasks, and leaves other relatively important tasks ignored. The module is regimented. It does not allow users to select which task they would like to learn first, and they must progress though a series of steps to complete the training before moving on to the next training module. The free training is basic in its design, and has been developed for a general K-12 audience. This type of generic training leaves a vast majority of teachers with very basic skills, and little room to grow in their use of the device. Understanding the device and how to use the software is crucial. To solidify a deeper understanding of more tasks, a paid professional training is also offered, but is often cost-prohibitive to school systems. To save printing costs and encourage teachers to attend paid professional training sessions, the interactive whiteboards are shipped without manuals. Without a manual, it is difficult for teachers to troubleshoot their own problems, and often leads teachers to become frustrated and confused when trying to solve a technology issue on their own.

## Problem Statement

This study was designed to determine how K-12 teachers without prior experience in using interactive whiteboards begin using and integrating them in their classroom practices. While current research has focused on overall technology use in school systems, little attention has been given to the process that teachers utilize when implementing new instructional technologies into their classrooms. Moreover, there is a gap in the research when looking at teachers who did not receive formal training in integrating technology into their curriculum, and how they go about gaining knowledge authentically.

## Purpose of the Study

This qualitative case study addressed how K-12 teachers without prior experience in using interactive whiteboards begin using and integrating them in their teaching practices. Research from this study could be used to inform the educational technological training community about procedures and avenues that teachers take when implementing new instructional technologies in their classroom, and steps they may take when seeking technical assistance. This information could help streamline the training process and better inform trainers, educators, and administrators in technology use and integration.

## Research Questions

This study addressed five research questions:

1. *How do K-12 teachers without prior experience in using interactive whiteboards begin using and integrating interactive whiteboards in their teaching practices?*

2. *What type of technology training do teachers perceive as beneficial in helping them to use interactive whiteboards in their teaching practice?*
3. *When encountering technological problems that prevent them from fully utilizing the features of their interactive whiteboards, what kind of troubleshooting techniques do teachers use before seeking a technician's assistance?*
4. *Do teachers, at the elementary and high school level, have similar problems with interactive whiteboards and employ similar problem-solving strategies?*
5. *Do teachers, at the elementary and high school level, use interactive whiteboards in similar ways?*

**Conceptual Framework**

The researcher used the following frameworks and concepts to understand the intricacies of technology application and integration: The Technological, Pedagogical, and Content Knowledge framework (Koehler & Mishra, 2004), the Concerns-Based Adoption Model (Hall, Wallace, & Dossett, 1973), and the concept of andragogy (Knowles, 1980). The frameworks and concepts were used to help guide the researcher when coding and interpreting the data.

The Technological, Pedagogical, and Content Knowledge framework (TPACK) was the initial framework used in understanding how teachers developed and combined their knowledge of content and pedagogy, and how it applied to their development of technology knowledge. Developed by Koehler and Mishra (2004), the TPACK framework is used in the field of Educational Technology to understand the complex interplay between technology, pedagogy, and content knowledge acquisition. Some have argued that technology knowledge cannot be

examined in isolation; instead, knowledge of technology, pedagogy, and content need to be examined in conjunction with each other to understand how knowledge is acquired (Angeli & Valanides, 2005; Niess, 2005; Blanchard, Harris, & Hofer, 2010).

The content knowledge portion of TPACK is the knowledge of subject matter that is taught in the classroom. Teachers actively draw upon their content knowledge to provide content-specific examples in class. Content knowledge is focused on central facts, prevalent theories, and the understanding of concepts as they relate to the subject. Teachers use their understanding of content to express and connect ideas, as well as develop the foundation for future knowledge acquisition. Teachers without an understanding of content knowledge can misrepresent information and stymie a student's understanding of subject matter (Ball & McDiarmid, 1990).

Pedagogical knowledge is used when teachers employ a variety of teaching methodologies to help students grasp complex concepts and material. This knowledge is used to manage the classroom, develop lesson plans, and gauge students' understanding of content. Pedagogical knowledge is a broad field of knowledge because it not only covers the process of managing a classroom, but also focuses on how children construct knowledge and the social and developmental theories of learning.

Technology knowledge is used when teachers implement technology to help deliver information in the classroom. The term technology is used in the broadest sense in the TPACK framework. Technology can include dry erase boards, books, and even advanced technologies such as computer software and interactive whiteboards. Technology knowledge is ever-evolving

because new technologies are often implemented in the classroom. A teacher with a firm understanding of technology knowledge is able to adapt new technologies to the classroom environment, and understand how the subject matter can be enhanced by the application of technology.

The framework for TPACK is derived from the center of where technological knowledge, content knowledge, and pedagogical knowledge intersect. Each field of knowledge holds valuable information that teachers use on a daily basis. During instruction time, teachers use all three of these knowledge fields to deliver their lesson. TPACK focuses on the knowledge that is developed when all three fields of knowledge intersect. This understanding of all three realms of knowledge allows the teacher to explain, connect, and present information in a variety ways for students to grasp. A diagram of the TPACK framework can be found in Appendix A.

The Concerns-Based Adoption Model (CBAM) was used to understand the process of incorporating technology into the curriculum (Hall, Wallace, & Dossett, 1973). CBAM is a widely used model when evaluating the process of technology adoption. Used in a variety of school communities around the country, CBAM breaks down technology adoption into seven stages. The individual proceeds through the stages of: awareness, informational, personal, management, consequence, collaboration, and refocusing (Hall & Hord, 2001).

The model is important because it outlines the concerns the teachers proceeded through while integrating the interactive whiteboards into their curricula. The researcher used this model to determine which stage the teacher was in during the implementation of the interactive whiteboard. The model was also used to understand the feelings, thoughts, and reactions the

teachers had about integrating the interactive whiteboard into their classrooms (George, Hall, & Stiegelbauer, 2006). A diagram of the CBAM diagram can be found in Appendix B.

The concept of Andragogy provided the researcher's understanding of what motivated adult learners to engage in the process of learning how to use the interactive whiteboards. The concept that adults and children learn differently is not a new one. Malcolm Knowles (1980) popularized the term andragogy, which focuses on adult learners and the experiences they bring with them when they enter the classroom (Knowles, 2005). The term andragogy is derived from the European concept of teaching and learning, and is contrasted with the idea of pedagogy. Andragogy is, "the art and science of helping adults learn," whereas pedagogy is, "the art and science of helping children learn" (Knowles, 1980). Andragogy is based off of six assumptions that are related to how adults learn. The assumptions include: need to know, foundation, self-concept, readiness, orientation, and motivation. These assumptions were used to better understand what motivated each teacher, and how that motivation impacted the teachers' implementation of the interactive whiteboards into their curricula.

**Significance**

The majority of the current research that exists about the use of interactive whiteboards in the classroom is quantitative in nature, and focused on achievement test data, student motivation, and teacher/student perceptions of technology use in the classroom (Smith, Higgins, & Hardman, 2006; Smith, Higgins, Wall, & Miller, 2005; Higgins, Beauchamp, & Miller, 2007; Marzano, 2009). Since interactive whiteboards are becoming more common in the classroom environment, an investigation into how teachers deal with the difficulties associated with such tools is

necessary to help understand what training teachers need so they will be able to use whiteboards effectively. This research could also benefit advances in technological training because it is focused on the teacher, not solely on the instructional technology being used.

**Delimitations**

The researcher selected study participants from one school system. In order to ensure that all participants had equal background with interactive whiteboard, each participant received an interactive whiteboard without prior training. They were selected by their principals for their willingness to participate. All participants taught in either an elementary or high school setting. The participants all used Promethean interactive whiteboards, hardware, and software.

**Limitations**

A limiting factor for this study was the distribution of interactive whiteboards within the schools available for inclusion in this study. The elementary school that was used in this study had a ubiquitous environment with an interactive whiteboard installed in every classroom. On the other hand, interactive whiteboards were installed in only a few classrooms at the high school examined in this study. The Math department was the only department to have an interactive whiteboard in every classroom. This makes it difficult to compare these two school settings because only the Math department at the high school had a ubiquitous interactive whiteboard environment.

In order to access the teachers within the school system, the researcher was required to meet with each principal. The researcher worked with the local principals to select participants who recently received an interactive whiteboard but no formal training. From the initial meetings

with principals, twelve participants were asked to participate in the study. Six high school math teachers and one social studies teacher in the math hall were invited, but only two math teachers and the social studies teacher elected to participate. Only three out of five elementary teachers agreed to participate in the study. The participants that elected not to participate in the study stated that they were either overwhelmed with the new technology, receiving a student teacher, or receiving practicum students and did not have time to devote to the research process. Because the principals showed concern about their teachers' involvement in other activities, they limited the researcher's participant pool, leaving a sample size of six willing participants.

**Definition of Terms**

The following are some of the key definitions that will be used throughout the study:

Acetate – a transparent sheet that is made of cellulose. When used with an overhead projector, a light passes through the sheet and is projected onto a wall or screen.

Andragogy – the process of engaging adult learners through various strategies that focus on motivation. These strategies include: providing a reason for learning, activities based off of relevant experiences, included in decisions based on their education, information relevant to their career, internally motivated, and responding better to problem-centered examples.

Constructivism – a learning theory that argues that knowledge is bound within the context, and learners create personal meaning from their own experiences.

Educational Technology – the study and ethical practice of facilitating learning and improving performance by creating, using, and managing appropriate technological processes and resources (Lowenthal & Wilson, 2010).

Elmo Document Camera – a camera mounted above a lighted platform and attached to a projector. The camera is used to display images, worksheets, and hand-held manipulatives in real-time to students through a projector. The camera connects through VGA and USB connections and provides 10X zoom.

Interactive Tablet – a touch sensitive hand-held device that controls the computer and provides the same interactive elements as an interactive whiteboard. For this study, participants used Promethean's ActivSlate.

Interactive Student Response System – a hand-held device given to the students that allows them to interact with an interactive whiteboard. The devices are used to aggregate data and provide feedback for the students and the instructor. These devices are also known as clickers, classroom response systems, ActiVotes, and group response systems.

Interactive Wand – a wand that students use to extend their reach when interacting with the interactive whiteboard. For this study, participants used Promethean's ActivWand.

Interactive Whiteboard – a generic term used to describe a device that displays projected images from a computer. The user may interact with the computer via the whiteboard, essentially creating a large tablet computer that is centrally located in front of the classroom. The interactive whiteboard brand used in this study was Promethean. The participants used the term Promethean Board, interactive whiteboard, and board interchangeably.

Integration of Technology – a process of increasingly utilizing some form of technology within regular instructional practice and daily routines. Fully integrated technology is utilized

seamlessly, routinely, efficiently, and effectively (Technology in Schools Taskforce, 2003, as cited in Lawless & Pellegrino, 2007).

Instructional Technology – term used to describe any computer-based technology that is used to promote education.

No Child Left Behind – a reauthorization to the Elementary and Secondary Education Act (ESEA), which focuses on the four principles: accountability for results, more choices for parents, greater local control and flexibility, and greater emphasis of research-based scientific research (U.S. Dept. of Education, 2011).

Pedagogy – the methods and principles used for instruction. Pedagogy is the implementation of learning theories and instructional practices in the process of teaching.

PDF File – Portable Document Format made by Adobe Systems. This document is designed to provide a unified format available on all machines with a degree of copy protection. Teachers used PDF files to import, display, and share information.

Situated Learning – learning in an environment in which the context is applied.

Traditional Classroom – this term represents a teacher-focused approach within the classroom setting. The teacher provides the knowledge, and the students passively receive the information.

TrueCrypt – an open-source software encryption program that is used to secure important files. TrueCrypt is unique in that it has no backdoors that allow third party agencies the ability to access the content stored on the drive. The only person that has access to the data is the individual with the password.

Ubiquitous Technology – for the purpose of this research study, this expression refers to instructional technology being common within the school and classroom and playing a vital role in the education process.

USB – Universal Serial Bus. A universal connector designed to interface with a variety of systems. In the interactive whiteboard setup, USB connection to the computer is required for interactivity.

**Outline of the Study**

Technology advancements have changed the way teachers educate schoolchildren in the United States. With each advancement, teachers are given new tools that they may or may not be prepared to utilize and integrate. After this introduction to the interactive whiteboards and their integration into the classroom, the following chapters address the acquisition of technology skills and troubleshooting, teacher training, and implications of the process by which teachers integrate interactive whiteboards into their classrooms. The review of literature in Chapter Two first examines teachers' perceptions of technology and its integration. The review also includes conceptual frameworks related to teachers' integration of interactive whiteboards in their classrooms. Chapter Three details the methodology of this qualitative study, including the research design, data analysis, and validation strategies for the data collected. Chapter Three also gives a brief description of the pilot study that was conducted in 2010, setting the foundation for the methods and procedures of the current study. Chapter Four features specific answers to each research question as it relates to each participant. Finally, in Chapter Five, a discussion brings

the literature and the current study together to present discussion, conclusions, and recommendations for future research and teacher training.

# Chapter 2

## Review of the Literature

School systems nationwide are continuing to add more technology to classrooms hoping that these new technologies will increase students' tests scores (Ingelbrecht & Jones, 2010). During the 2003-2004 school year, school districts in the United States spent $7.87 billion on technology equipment alone (Stevenson, 2004). Within the same year, the United States Department of Education supplied $659,438,400 in grants designed to promote professional development that encouraged the integration of technology into the curriculum (Lawless & Pellegrino, 2007). The spending trend continues with a large emphasis placed on Science, Technology, Engineering, and Mathematics (STEM). The amount of instructional technology that is entering the schools is far outpacing the amount of research educational technologists can conduct to determine the best use for the technology. School systems are spending money without a clear understanding of how the technology will impact their teachers and students.

Researchers who support the increase in technology spending argue that technology integration may provide a cost effective way to increase student achievement (Mann, Shakeshaft, Becker, & Kottkamp, 1999). Other researchers argue that simply placing new technologies into classrooms will not affect achievement scores (Cuban, 1986; Cuban, 2001; Stoll, 1995; Zhao, Pugh, Sheldon, & Byers, 2002; Georgina & Hosford, 2009). Researchers do agree that there should be more focus on the relationship between technology, pedagogical techniques, and content knowledge, as well as teachers' perspective of technology use (Mishra & Koehler, 2006; Niess et al., 2009).

Clark (2002) focused on teacher perspectives of current technology use in a middle school environment. In his qualitative case study, he focused on twenty-eight teachers who already had technology in their classrooms. He observed and interviewed teachers to discover their perspectives about technology use in a middle school environment. The teachers' perspectives varied depending on their comfort level with the technology. He concluded that teachers welcome the use of instructional technology, and consider it an integral part of the middle school curriculum. He also found that teachers would consider implementing new and different types of technology into their curriculum.

Vannatta and Beyerbach (2000) focused on technology use of preservice teachers and university faculty. The study focused on the second year of a grant project entitled, "Goals 2000: Preservice Technology Infusion Project." The grant was used to help education faculty and preservice teachers "gear up" and "integrate technology into their instruction to facilitate a dynamic approach of a constructivist vision of technology integration" (Vannatta & Beyerbach, 2000). The researchers used a mixed methods approach and focused on the skill levels of teachers and educational faculty. A workshop-style training was used to enhance basic computer knowledge for both the educational faculty and preservice teachers. Vannatta and Beyerbach found that both preservice teachers and educational faculty needed similar support in utilizing and integrating technology.

To understand teachers' perceptions of technology use in the classroom, Wozney, Venkatesh, and Abrami (2006) surveyed 764 elementary and secondary teachers in both private and public schools. The researchers developed the Technology Implementation Questionnaire

(TIQ), which consisted of 33 belief items that centered on value of technology, expectancy of technology use, and cost of technology use. The researchers also surveyed teacher demographics, issues with the current use of technology, and the resources that were made available to teachers.

Wozney, Venkatesh, and Abrami (2006) found that teachers who perceived that the technology would help them deliver information more easily responded favorably to the technology. In other words, when teachers were given clear use cases for the technology, they were able to see how they could adapt it to their classroom curricula. Researchers also found that the more exposure that teachers had outside of the classroom with technology, the more comfortable they were with using the technology in their classrooms. The study also revealed that teachers will predominately use technology as an informative method of curriculum development. The teachers used the Internet to gather information about content that they were teaching as well as methods and techniques for teaching the content. The survey also indicated that teachers preferred a ubiquitous technology environment to a classroom with limited technology and resources.

Research indicates that before instructional technology can become a tool used to significantly impact curriculum on a large scale, it must be ubiquitous (Barnett, 2003; Russell, Bebell, Cowan, & Corbelli, 2002; Silvernail & Lane, 2004). The term ubiquitous in this case refers to technology that is always present and always available for teacher and student use. The researchers indicated that unrestricted access to instructional technology should be as commonplace as access to paper and pencil. Students should have full time access to laptops, interactive whiteboards, and the Internet.

One of the earliest and largest efforts to provide a ubiquitous instructional technology environment was the Maine Learning Technology Initiative (MLTI). This initiative provided students with laptops they could use both at home and at school. Garthwait and Weller (2005) studied the impact of this ubiquitous environment by tracking seventh grade students within two science and math classrooms. Using a qualitative case study design, the researchers sought to find how the introduction of each student having unrestricted access to a laptop would interact with the teachers' teaching styles, and problems the teachers may encounter in that type of environment. The teachers commented that the use of instructional technology increased the quality of work that students completed. The researchers also found that student interest and motivation to complete assignments had increased dramatically.

Garthwait and Weller (2005) also found that ubiquitous instructional technology computing did not guarantee a shift to student-centered teaching. The most critical element for the successful use of the technology was the teacher's involvement in lesson development. The teachers were confident that the students benefited from immediate access to the laptops, and four out of five teachers stated that the students were more motivated to complete the assignments, even though student performance did not increase.

Krentler and Willis-Flurry (2005) found adding instructional technology to the curriculum increased both student interest and performance on course material. The researchers studied student performance on discussion boards in a marketing course. The level of student participation in the discussion boards was compared to performance on the assessment

instrument. The researchers found a positive correlation between amount of participation on the discussion boards and scores on the assessment instrument.

Weglinsky (2005) also found that teacher involvement in technology integration is crucial for a ubiquitous technology environment to be successful. He analyzed data from a survey distributed in conjunction with the twelfth grade U. S. History assessment conducted by the National Assessment of Educational Progress (NAEP). The study found that students who regularly used technology to complete assignments demanding higher levels of thought performed higher on standardized tests. His study also revealed students who regularly used technology performed worse on the exam. At first glance, these data seem to be contradictory, but Weglinsky explained that students treat technology as a tool, and teachers should focus on assignments that promote higher-order thought processes.

Deboard, Aruguete, and Muhlig (2004) also found no connection between use of technology and student performance. The researchers modified a traditional college course by replacing the traditional overhead transparencies with PowerPoint presentations that contained the same information. The researchers also added a website that contained the syllabus, instructor's notes, practice tests, and study guides. These adjustments were compared to a control group taught by the same instructor. The modifications to the class did not increase student performance, but the researchers noted that students were more willing to participate in discussion, and more willing to ask for clarification. The researchers also reinforced the notion that replacing one technology with another will not make an impact on student achievement.

While the implementation of instructional technology in the classroom has not made the significant changes in student achievement like many had hoped, its use in the curriculum has offered more efficient ways of knowledge acquisition. Mann et al. (1999) found that students showed gains in achievement when computer-based drill and practice programs were added to a student's curriculum. This drill and practice routine lightens the burden on the teacher because the computer program becomes the tutor by providing guided practice. The researchers also concluded that the learning gains found by the study were more cost effective than similar gains accomplished by lowered class sizes.

Fitzpatrick and Fauz (2002) found that while there was not an improvement in student performance on traditional assessment measures, there was a positive correlation between technology integration and student interest in course content. The instructor of the course reduced the amount of technology used within the course because he found it distracting and was not able to correctly use presentation hardware and computer software when presenting the material. When the use of technology declined, student interest also declined. The researchers determined that support should be established when asking teachers to incorporate technology in existing course material so that the technology is not in the way of quality instruction.

New technologies are being introduced to teachers each year. From computer programs to special calculators to interactive whiteboards, each technology promises better instruction and better test scores. As our knowledge of how to best implement these new instructional technologies matures, researchers are finding evidence to suggest that instructional technologies enhance student achievement the most when they are used as tools to accomplish learning

objectives designed by a teacher (Silvernail & Gritter, 2007). The teacher being the agent of change in the classroom is often overlooked because new devices promise to make learning new content easier. The use of technology to create a content-based product should be the main goal for the student, and the product should be something that displays the students' mastery of the content in the curriculum (Weglinsky, 2005). The content should continue to be the focus rather than the newest piece of technology.

**Technology and Pedagogy**

Researchers suggest that the implementation of instructional technology has not only changed the way we deliver content in the classroom, but it has caused teachers to move from a traditional style of teaching to a constructivist model of teaching (Becker & Ravitz, 1999; Cronje, 2006; Kitchenham, 2006; Levin and Wadmany, 2006; Rakes, Fields, & Cox, 2006). A constructivist model is often characterized as student-centered teaching, as opposed to teacher centered teaching. The teacher takes the role of facilitator and allows students to learn through self-discovery and knowledge from their previous experiences.

Vanatta and Fordham (2004) surveyed 177 teachers about their attitudes toward technology and its use in the classroom. The study revealed that of the participants, there were two contrasting pairs of primary teaching philosophies. The first contrasting pair was constructivist versus traditionalist teaching techniques. The second was teacher-centered versus student-centered lesson plan design and implementation. The study also found that willingness to change was a large factor in a teacher's attitude toward technology integration. The researchers found that willingness to change centered around two basic concepts. The first was the amount of

extra time a teacher was willing to spend in understanding a new technology. The second was the amount of training that the teacher received.

Becker and Ravitz (1999) found a correlation between growth of constructivist pedagogical beliefs and computer use. The researchers surveyed 726 teachers of the 153 schools included in the National School Network. The National School Network was a select group of schools that received funding for high-speed Internet access from the federal government in 1995. The survey was equally distributed to elementary, middle, and high school teachers. Teachers who were identified as frequent Internet users completed a follow-up study that measured changes toward constructivist practices. The survey results indicated that teachers who frequently used the Internet demonstrated more constructivism-based activities than other teachers.

Becker and Ravitz (1999) also found that elementary teachers reported the biggest change toward constructivist practices than any other group. Secondary education teachers demonstrated the strongest correlation between constructivist practice and their use of computers. The most important revelation from the study was the similarities shared by the teachers moving toward constructivist pedagogy. They had access to the Internet for a period of at least three years, were willing to discuss subjects in which they lacked expertise, managed multiple activities during class time, assigned long and complex projects for students, and gave students greater choice in the tasks and resources used to complete their projects. The teachers also promoted more student productivity, and were willing to allow students to engage in discovery-based education.

Ravitz, Becker, and Wong (2000) conducted a national survey of 4,038 in-service teachers to determine if their perceived pedagogical beliefs were the same as their practiced pedagogical beliefs. The researchers used the teaching, learning, and computing (TLC) survey to determine if teachers favored a constructivist pedagogy in delivering content information. The researchers found that a majority of teachers preferred constructivist pedagogy, but also felt that they needed to conform to the pressures of the environment and high stakes testing. This led the teachers to adopt a more traditional method of teaching because it allowed them to cover the material in a shorter amount of time.

Rakes, Fields, and Cox (2006) investigated the relationship between technology use and constructivist practices of teachers in rural environments. The researchers administered Moersch's Levels of Technology Implementation (LoTi) survey to teachers who taught fourth and eighth grades. The survey was administered to 11 school districts to determine if there was a connection between the levels of classroom technology use and personal computer use, in relation to constructivist pedagogy. The researchers found a significant positive relationship between both the levels of classroom technology use and personal computer use. The researchers also reported finding a positive relationship to the use of constructivist pedagogy, with the strongest indicator being the amount of personal computer use.

Levin and Wadmany (2006) conducted a longitudinal study that focused on the evolution of teachers' beliefs of learning, teaching, and technology, and how it related to their current instructional practices. The study centered on six teachers who taught in fourth through sixth grades, and how they integrated technology into their classroom instruction and work that they

assigned to their students. The researchers used interviews, questionnaires, and observations to understand how teacher beliefs influenced classroom practices. The researchers found that after several years of using instructional technology in the classroom, teachers' classroom practices changed dramatically. Their assignments focused more on student-centered projects as opposed to teacher-led projects. Although all the teachers shifted the way they taught, not all of them shifted their beliefs about technology and how it should be used in the classroom. The researchers summarized that it is easier to change classroom practices and behavior than educational beliefs.

Kitchenham (2006) studied the effects of professional development and how transformative learning applies to instructional technology integration. The research focused on 10 teachers and how they applied information they learned from professional development opportunities. Data were gathered through the use of reflective journals maintained by the participants, a teacher questionnaire, semi-structured interview questions, and the researcher's field notes. The researcher found that as teachers became more comfortable with the use of technology and worked in an instructional technology-filled environment, they were more likely to move toward constructivist tendencies when implementing technology in their curriculum.

In a more recent study, Choi and Ramsey (2010) explored elementary school teachers' beliefs, attitudes, and practical knowledge, and if they could be altered through the participation in a summer science course. Surveys and a case study were administered to 14 elementary school teachers before and after they completed the three-credit-hour summer course. A majority of the participants improved their knowledge and skills in conducting constructivist-based

instruction. The data also indicated that the teachers were clearly influenced by the course material and planned to implement the strategies into their classrooms.

Not convinced that technology had altered teachers' pedagogical tendencies, Cuban, Kirkpatrick, and Peck (2001) conducted a qualitative study of two Silicon Valley high schools to determine if pedagogical practices were altered in a ubiquitous instructional technology environment. The researchers discovered that teachers infrequently used the tools that were available to them. Teachers also adapted the instructional technology to fit their pre-existing teacher-centered practices. The authors suggested that the time needed to understand the technology and implement it into practice was too high.

Windschitl and Sahl (2005) postulated that the reason that research has not proven that technology use changes pedagogy is because there needs to be more investigation into the social context in which teachers are trained. The researchers conducted a multi-case study to investigate how the context of an institution influences teachers' perceptions and attitudes toward technology. The results of the two-year study found that the use of technology did not shift the teacher toward constructivist practices. Instead, teachers simply fit the technology into their existing pedagogical beliefs.

A study by Schmid (2006) explored the use of interactive whiteboards through the lens of the critical theory of technology. Schmidt describes the critical theory of technology by suggesting that technology's use should be considered to be the product of the technology's design and the way it is implemented. To summarize, the actual impact of technology may only be understood after considering the purpose of the device, the understanding and beliefs of the

teacher, the way the teacher uses the device, the attitude of the students, and the environment in which the device is used. To understand technology's impact on the classroom teachers have to not only focus on the technology, but the content and pedagogy as well.

**The TPACK Framework**

The idea of focusing on content knowledge and pedagogical techniques is not a new one. Shulman (1986) proposed that instead of treating them as separate entities, one should focus on the intersection of these two realms. By focusing on the intersection, researchers would be able to identify what constitutes exceptional teaching. Pedagogical content knowledge includes the complex interactions between teaching the given material, developing content specific examples, and articulating the material in a way that is digestible to the given audience. This complex interplay holds the key to exceptional teaching.

Since the inception of pedagogical content knowledge, researchers have adapted, critiqued, and modified the original idea and applied it to different fields. With the influx of technology in the classroom, researchers have added technology content knowledge to Shulman's notion of pedagogy and content knowledge. Technological pedagogical content knowledge (TPACK) builds on the foundation of pedagogical content knowledge and also focuses on how teachers effectively integrate technology in the classroom (Mishra & Koehler, 2006).

The TPACK framework is a result of an on-going design experiment by Mishra and Koehler (2006). The researchers found that not only did teachers develop content-specific examples and translate the material for the audience, but they also had to understand and adapt

their approaches with the use of classroom technology. The addition of technology has added to the complexity of the teaching process. This complexity has also led to insight in how to teach teachers to use instructional technology, and how to connect teachers' knowledge of content and pedagogical techniques.

The crux of TPACK lies in the center of where Technological Knowledge, Content Knowledge, and Pedagogical Knowledge intersect. Each field of knowledge holds valuable information that teachers use on a daily basis. During instruction time, teachers draw from all three of these knowledge fields to deliver their lesson, provide content specific examples, and use technology to further enhance the classroom content.

Technology Knowledge is the knowledge that teachers use to interact with a range of technologies. Standard technologies, including books, dry erase boards, chalkboards, and traditional overhead projectors require little training to implement in the classroom. Advanced technologies like computers and interactive whiteboards require specialized advanced-level skills that are not always intuitive to the teacher without training. Before teachers can use computers, they must understand how to interact with them.

To use a computer, the teacher needs to understand how to use a keyboard and mouse to interact with the computer's operating system. These skills include when to click on an object on the screen, knowing when to use the left mouse button to click once or twice, and when to use the right mouse button. To use an interactive whiteboard, the teacher must first have mastered the use of the mouse and keyboard. The interactive whiteboard uses the same skills that a teacher

has already developed with the use of the computer, but also includes a complex array of features that are only relevant to the interactive whiteboard.

Once teachers have mastered the user interface of these devices, they need to learn how to use the software that often comes with the computer or interactive whiteboard. Mastery of the software, the ability to navigate the Internet efficiently, how to install and remove devices, and how to find and save files to be used with the interactive whiteboard are all essential skills that need to be developed when using interactive whiteboards. Because advanced technologies like computers and interactive whiteboards are complex and new technologies are entering the classroom every few years, the process of learning these technologies takes away valuable time that teachers would spend normally developing their content and pedagogical knowledge.

Content Knowledge is the knowledge that is attained by specializing in a given content area. In the U.S., middle school and high school teachers specialize in a content area and are responsible for teaching that material to their students. These teachers are considered subject matter experts and possess the ability to intrinsically connect facts and commonly accepted concepts. The grade level of the course content generally dictates the depth and breadth of the content. This does not mean that a content area expert will solely focus on the grade appropriate content. Often, teachers will reconnect information that was learned in previous grade levels to provide a relevant connection to the material (McDiarmid & Ball, 1988).

Pedagogical Knowledge is the knowledge that teachers use in the classroom to facilitate teaching and learning. This knowledge includes concepts of classroom management, learning constructs, and an understanding of the educational environment as a whole (Koehler & Mishra,

2008). Individual and group assessments are important parts of pedagogy. Pedagogy teaches the teacher to look for specific performance indicators in their students' work. Pedagogy also includes educational theory and strategies for delivering the material. Teachers who have strong pedagogical skills know what motivates students in their classrooms. Pedagogy knowledge gives the teacher the ability to develop engaging lesson plans and achieve curriculum goals.

Technological Pedagogical Knowledge is located at the intersection between technological knowledge and pedagogical knowledge. An example of this type of knowledge would be a teacher using PowerPoint to create an interactive "Jeopardy" themed game. The teacher combines the knowledge of PowerPoint (hyper-linking, transitions, and animations) with the knowledge of effective testing and review techniques. The teacher could follow up by posting this type of review game on the class website or wiki for a student to review before the test. Technological pedagogical knowledge gives the teacher the ability to find a technology and mold it to fit the classroom need (Barbour, Reiber, Thomas, & Rauscher, 2009).

Technological Content Knowledge is the knowledge that resides at the intersection of technological knowledge and content knowledge. This knowledge allows the teacher to find and identify computer applications that foster content through computer-based instruction. An example would be the use of Mathematica. Mathematica allows a teacher to explore a variety of math concepts that could not be explored without a computer. Mathematica allows students and teachers to develop and alter mathematical formulas. The software also allows instant output of graphs and tables that can be adjusted in real-time. With the flexibility of Mathematica, teachers

and students can explore different math concepts and principles. This type of computer-based instruction allows students to delve deeper into math concepts (Coffee, 2004).

Technological Pedagogical Content Knowledge breaks down the complex multifaceted nature of teacher knowledge, and focuses on how teachers cultivate knowledge from the three primary forms (Brush & Saye, 2009). When developing this type of knowledge, teachers often reach out to other colleagues to develop new strategies for teaching and learning.

Using the framework of TPACK to develop technology teacher training is an efficient way to teach teachers not only how to use the technology, but also how the use of technology can promote and facilitate learning. To develop TPACK knowledge, the training and examples need to be situated in the environment and focused on the content area that the teacher teaches (Koehler, Mishra, Hershey, & Peruski, 2004). Because TPACK focuses on the different realms of knowledge, teachers can focus on the realm they feel the weakest in to develop their skills.

An example would be a teacher developing skills in pedagogical techniques and technology integration knowledge. The teacher may have trouble balancing the amount of content delivered and the time students need to digest the material. Pulling from knowledge of pedagogical techniques, the teacher can remember that students need 15 to 20 minutes to categorize and connect new information. Realizing that the students were not given enough time to grasp the material, the teacher can decide to use knowledge of technology applications to find an electronic timer to use to pace the class by remembering during professional development training that another teacher found a website that functioned as a simple timer. Because the professional development session focused on building the teachers' domain of technology

knowledge, the teacher is able to incorporate the website into the classroom by using the timer to allow enough time for the students to grasp the material.

Another advantage that TPACK has over other technology integration training models is that it specifically focuses on the development of technology-rich content delivery. Harris (2008) found that teachers are more likely to integrate technology in their classrooms when the training is linked directly to students' content-related learning needs with content-based learning examples. Unlike the more widely known technology frameworks like the International Society for Technology in Education (ISTE) NETS-T 2000 Standards (ISTE, 2000), Apple Classrooms of Tomorrow (ACOT) (Sandholtz, 1997) and Levels of Technology Integration (LoTI) (Moersch, 2002), which are specific to educational technology integration, TPACK focuses on the combination of technology, content, and pedagogy to reach a teacher's overall classroom goals.

**Andragogy**

Researchers have presented evidence that the implementation of instructional technologies including interactive whiteboards, computers, and other software packages, do not automatically improve student performance. The teacher is the determining factor in how the technology will be implemented, how it will be combined with the curriculum, and if the implementation will be successful (Gatlin, 2004). Before the implementation of instructional technology can improve education, teachers must understand how to use the technology, and how to best combine it with the content that they teach. For teachers to understand the intricacies

of how technology can be implemented, they need to be trained in the use of the technology and understand its purpose in the classroom.

Understanding how newly installed instructional technologies can be used in the classroom is not easy. Teachers should participate in professional development to better understand the technology, why it was implemented, and what they should expect from the new technology. “At the core of each and every successful educational improvement effort is a thoughtfully conceived, well-designed, and well-supported professional development component” (Guskey, 2000).

A well thought-out professional development program is difficult, because the instructor needs to have intimate knowledge of the technology, be able to answer a plethora of questions, and provide relevant examples in how the technology works. To add to the complexity, professional development instructors need to provide relevant classroom examples and connect the training with the experience that teachers bring with them. A traditional instructor-focused lecture is not an efficient way to teach how to implement new technology in the classroom. Instead, the instructor needs to be aware of teaching techniques that work best with adult learners.

The concept that adults and children learn differently is not a new one. Malcolm Knowles popularized the term andragogy, which focuses on adult learners and the experiences that they bring with them when they enter the classroom (Knowles, 1968). The term andragogy is derived from the European concept of teaching and learning, and is contrasted with the idea of pedagogy.

Andragogy is, “the art and science of helping adults learn,” whereas pedagogy is, “the art and science of helping children learn” (Knowles, 1980).

Knowles (1980) proposed four assumptions that differentiate adult learners from children. These assumptions are based on maturity, work, social experience, and focus on immediate application of material. In later publications, he shifted his focus from andragogy vs. pedagogy to the transition that learners progress though during their life and how maturity impacts their understanding of content. Knowles (1984) added two more assumptions that focused on internal and external motivators and why adults need to be informed about the relevance of the information they are learning (Merriam, Caffarella, & Baumgartner, 2007; Knowles, 1984).

The first major assumption is that as adults mature their dependence on others lessens, and they become more self-directed. When children enter the classroom, they are dependent on the knowledge that they received from their parents. As children progress through school, they gain knowledge that they can use to develop a foundation of understanding that they then can apply to the world around them. As that knowledge develops, children begin to make their own decisions, and through trial and error learn the ramifications of their actions.

When children enter adulthood, they are capable of making and dealing with their own decisions. Knowles’ argument is that when adults reenter the classroom, they are subjected to the pedagogical practices used to teach children. These teaching practices go against the adults’ concept of self, and they are left confused and frustrated because, in a sense, they have outgrown that role. Knowles argues that adults are capable of making their own decisions when it comes

to completing course material. Because of Knowles' revelation that adult learners should be encouraged to have an active role in their education, the field of adult education has, as Stephen Brookfield suggested, developed its own "badge of identity." This badge is used to differentiate the two distinctive fields of education (Brookfield, 1986).

Knowles proposed that an adult's willingness to learn is not only associated with age and experience, but also the psychological principle of developmental tasks (Knowles, 1968). Robert Havighurst (1955) surmised that humans must complete a specific task before moving onto another. An example would be children crawling before they walk. They must first develop leg strength before holding their own weight. Havighurst emphasizes that muscle development is not the main factor of a child choosing to walk. Instead, children must reach a point where they become frustrated with the slow travel of crawling, and prefer to move to the faster travel of walking.

Knowles uses this concept and applies it to the needs of adult learners in the second major assumption of andragogy. Adult learners will not desire to learn a new task or job unless they feel confident in their ability to complete their current task. An example would be a teacher who receives an interactive whiteboard. At first, the teacher will use the board in the way she feels comfortable. After the teacher feels confident in utilizing the board, she will move to more complex tasks that enable her teach the content in different ways.

When training teachers during in-service sessions, it is important to provide them with the material that is appropriate to the grade level that they teach. An adult educator cannot train the entire school system at once. Instead, adult educators should offer tiered training (beginner,

intermediate, and expert), and focuses examples based around the content and grade level that they teach.

The third assumption of andragogy is the accumulation of rich experiences that adults bring with them when they enter the classroom. Because of their age, adults are exposed to a wider variety of environments and have deep, rich experiences that they rely upon when learning new information. In contrast to an adult, Knowles (1968) explains that experience to a child is something that they receive passively. When children attempt something new, by default they will develop the experience and start to build a foundation of understanding from that experience. Knowles explains that for a child, the outside environment defines this experience. An example he provides is how children identify themselves. Knowles explains that children will describe themselves based on who their parents are, who their older brother or sister is, or where they live or attend school. Their experience is based on their outside environment.

Knowles explains that adults, by contrast, view experiences based on what we have or have not accomplished. A woman in her mid thirties may describe herself as a wife, a mother, or a successful teacher. Her self-identity is derived from her personal experience. Since personal experience is heavily valued as an adult, it should be utilized when teaching adults how to incorporate technology into their classroom.

Because adult learners bring with them valuable experiences, they should be discussed and frequently referenced through the in-service training process. Since adults use their experience to help make new connections with the material, they should be encouraged to share their experiences with others. By sharing experiences, adult learners validate their roles in the

classroom because they define themselves by their past experiences. Sharing experiences not only validates the adult learner's role in the classroom, but it also encourages discussion that helps develop insightful ways of using technology in the classroom.

One of the disadvantages of adult learners validating themselves from past experiences is the situation and climate of their former experiences. For example, a teacher who struggled with technology may be hesitant to go to an in-service training focused on integrating instructional technology in the classroom. To compensate for this hesitation, a trainer should promote open discussion within the classroom and provide the teachers opportunities to share their experiences with the group. Through the open dialogue, teachers will be able to identify and apply the material to their own development of knowledge. The sharing of others' experience, as well as the validation they receive from the group, will provide a nurturing environment that will promote learning.

Another assumption of andragogy that Knowles discusses is that adults have a different perspective of time when it comes to the application of knowledge. When children begin school, they are learning information that will help them progress through elementary school. The knowledge attained in elementary school will support them in middle school, and middle school knowledge will help them in high school. The knowledge they gain in high school should prepare them to enter the work force or begin college. In a sense, the knowledge they gained in youth does not have an immediate effect. Its effect is only realized when you are continuing to learn more complex concepts. Knowles explains that to a child, knowledge is a culmination of concepts stored in a reservoir for later use (Knowles, 1980). Knowles defines a child's

knowledge as subject focused because it is centralized on concrete concepts and facts. Because of the emphasis on concepts and facts, learning becomes more focused on the specifics of the problem, as opposed to what series of events caused the problem.

Adults prefer the immediacy of the information as opposed to knowledge-building experiences. Teachers have a wealth of experience that they rely on when learning new material. Because adults demand immediacy, technology training should be focused on how to improve their skills that impact their immediate goals. Some training options could be more efficient use of interactive whiteboards, tricks that a teacher can take advantage of with the interactive whiteboard, and resources that can be implemented after the training.

After much research, Knowles (1984) added a fifth and sixth assumption to the concept of andragogy. These two new assumptions examine internal and external concepts of motivation and how relevance is important to adults when learning new material. Knowles moved from his theory termed the "model of assumptions" (Knowles, 1980) to what he thought was a better description of his theory called the "system of concepts" (Knowles, 1984). Whether the new assumptions are actually separate from the original four, or simply additions to the concept of andragogy is unclear (Holton, Swanson, & Naquin, 2001).

Knowles' concept of internal and external motivations is a pertinent issue that needs to be discussed when developing training curriculum for teachers. Adult learners are internally motivated to learn and improve their situations. These internal motivations include becoming more efficient with technology, technology use to enhance content delivery, and enriching content for the students. On the other hand, children respond to external forms of motivation.

Elementary-aged children strive to gain the acceptance of their teachers. An example would be a student striving to be the student of the week. This teacher-created position is only held by a student who completes assignments, produces good work, and is respectful to the teacher and other students in the class.

The final assumption that Knowles proposed is the relevancy of the information the adults are learning. Adults need to know how the information they are learning will impact them in their immediate future. Since teachers who participate in in-service training are continuing their education to improve their knowledge of technology use, they want to make sure that the information they are learning is pertinent to their grade level and content area.

**Andragogy Debate**

While Knowles concept of andragogy has provided a different point of view for how to examine adult education, it is not without its critics. The most notable critic of andragogy is a former professor of Knowles, Cyril Houle. Cyril Houle (1972) viewed andragogy as a set of techniques that can be incorporated into pedagogy. Houle argued that education is a single developmental process that extends the duration of an adult's life. He did agree that there are important differences between children and adults and how they view education, but argued that the differences are essentially the same when you compare how girls and women view education and how boys and men view education.

Similarly, London (1973) cautioned the field of adult education of adopting a dichotomous perspective. London agreed that some of the concepts from Knowles could also be applied to the education of children. He stressed the importance of keeping the field of education

unified and argued that separating the field of education into pedagogy and andragogy would cause confusion and add unneeded jargon to an already jargon-filled environment. London also questioned the motives of many of the researchers who were supporting the notion of andragogy. He believed that they were simply jumping on a bandwagon to achieve notoriety in the field of education.

Elias (1979) reaffirmed Houle and London's call for unity in the field of education. He argued that there were too many similarities between Knowles "models of assumptions" and the already established "pedagogy" to justify andragogy as a separate field of education. One of his strongest arguments centered on the notion that both a child and adult will demonstrate a dependent personality if they are introduced to material that is foreign to their knowledge, like learning a new language. Both the child and the adult would solely rely on the teacher to disseminate knowledge. The teacher would have to provide the support needed to learn a new language. It would be difficult for an adult, who according to Knowles would have enough self-direction to tackle the task of learning a new language, to be successful without dependence on the teacher.

Carlson (1980) argued against Elias, stating that he missed the point of Knowles' argument. Carlson surmised that Elias confused the concepts of teaching with the process of adult learning. In the example above, Carlson emphasized that material delivery would be the same. However, how adults use and combine the material with other knowledge and experience that they had gained in their earlier years in school, as well as their experiences in the work force would differ. Knowles (1979) himself reevaluated the notion of andragogy. He moved from the

position that andragogy was a learning theory, to more of a technique to use when teaching adults. Knowles acknowledged that he had made a mistake in subtitling his book *andragogy vs. pedagogy*. He indicated several points in his book that could be applied to both adults and children.

Houle (1972) proposed that learning was essentially the same process and experience for children and adults, and it would be if they all came to the classroom with the same knowledge and experiences. However, the educational environment is not contained within a vacuum. Each learner brings different experiences and dispositions to the classroom. The background and experiences of each learner affects how well he or she perceives information. Knowles third assumption of andragogy focuses on the experience that adults bring with them when they enter the classroom. Since children have a limited range of experiences, it is difficult for them to focus on their prior knowledge and apply it to new learning. Consequently, adults do learn differently because they have developed an understanding of the subject matter that relates to their own knowledge. Because their understanding is based on their own experience, they will interpret that information differently than a child.

As a child, information is provided to help build a foundation of knowledge that could be built upon later. With that foundation of knowledge, children learn what is appropriate and inappropriate in the classroom. Subjecting adult learners to the same type of traditional teaching techniques as roll call, assigned seats, and busy work would undoubtedly confuse and frustrate them. Western society prides itself on being individualistic about its outlook on life, but this idea does not seem to be translating to the classroom. By teaching adults with the same rigid

techniques that they were exposed to as children, teachers only belittle their accomplishments and may make them question the value of what they are learning.

There has been much debate about whether the concept of andragogy is relevant to the field of education. Hadley (1975) developed an instrument based on the assumptions proposed by Knowles that categorized the assumptions into an educational orientation scale. Researchers used the scale to test the theory and to determine if there were any identifiable characteristics that could be associated with the assumptions of andragogy. Despite early works by Katz (1976), Kerwin (1979, 1980, 1981) Holmes (1980), Hopkins (1981) and Jones (1982) in the orientation of andragogical and pedagogical preferences, and work by Christian (1982), Grubbs (1982) and Van Allen (1982) in the orientation of adult learners, no concrete data ever emerged to define andragogy as its own learning theory. In response to this, Hartree (1984) argued that Knowles concept of andragogy could never be defined. He explained that the concept that children learn differently than adults is a not arguable because Knowles was too vague in his assertions and provided no true examples on which to base this concept.

Despite the many attempts to assert that andragogy is a valid theory of learning, there has been no evidence that there is a difference between the way children and adults learn. Even today, researchers are still working to develop a generalized instrument to test andragogical assumptions (Holton, Swanson, and Bates, 2009). The notion that children and adults learn differently is a complex argument that has carried on for years. It is easy for researchers to lose sight of the real issue. Providing adults with successful teaching techniques will not only

enhance their position, but will also provide them with a meaningful educational experience that they will draw from in their daily activities.

**Teacher Training**

The benefits of andragogy not only apply to adults returning the classroom, but also to training environments. When teaching teachers how to incorporate technology into their classrooms, it is important to validate their prior experiences as teachers. This follows Knowles' third assumption of andragogy. When training teachers, trainers should recognize the content knowledge and pedagogical expertise teachers bring with them from the classroom to empower teachers to feel more confident when incorporating technology into their curricula.

Using Knowles' assumption that adults increasingly crave immediacy to the application of their learning, teacher training should focus on what is needed by the teachers. Teachers will be able to dialogue about their needs and questions as well as build knowledge for what they understand as their own needs. Rather than teach one large session to teachers from a variety of subject areas or grade levels, training should be focused on one particular group with similar needs.

Elementary teachers are not interested in learning about advanced mathematical tools built into a Promethean's ActivInspire. Instead, their time could be more wisely spent learning about the elementary mathematical tools they can use to directly impact their students. As they become more comfortable with the technologies they work with, they will be more likely to explore the technologies further and teach others about what they have learned. They will become less dependent on others and more self-directing with their approach to the technology.

Wlodkowski (2008) furthers Knowles's assumption of motivation, and postulates that it is a key to success when teaching adults. Wlodkowski suggested that adults are more motivated to learn information that directly relates to their careers. Adults, more specifically teachers, are pragmatic learners. They want to increase their abilities in teaching, and discover new ways to deliver content to their students. According to Wlodkowski, the Competence Learning Model claims that adults will naturally strive to achieve competence in their careers. This motivation and natural drive to become competent in their careers encourages teachers to attend technology training, and implement instructional technologies into their classroom.

Bruner (1966, as cited in Knowles, Holton, & Swanson 2005) also suggested that adult learners are driven by an intrinsic desire to learn new techniques as long as it benefits their career. Bruner points to inquiry learning as a method of engaging adults in the training process. Bruner suggested that when instructing adult learners, it is important to show them a variety of avenues to solve their problems. An example would be showing a few new techniques with the interactive whiteboard. The instructor could then ask for the teachers to provide other techniques for solving a specific problem. The adults place this new knowledge in the context of their social roles and curriculum development. This method allows the teachers to draw from their own experience so they can construct their own knowledge and apply it to their specific situation.

The concept of using self-constructed knowledge to enrich the training process is not a new idea. The constructivist learning theory suggests that learners will use previous experiences to enrich their understanding of the information that they are learning. When teachers are learning how to use an interactive whiteboard, they will draw upon their previous experience

with technologies that they view are similar and apply those techniques to the new technology. Teachers who participate in professional development training sessions are with like-minded individuals that share their same goals. Since teachers share the goal of understanding and utilizing the interactive whiteboard in the classroom, the learning process becomes social, and part of the school culture (Putnam & Borko, 2000).

When developing a professional development session, instructors should first evaluate the learners' needs and assess the material and information that needs to be shared, and with whom the information will be shared. Information should be delivered in the context that it will be used. Contextual authentic learning along with situated learning posits that the location of the learning adds to the meaning, and helps to shape understanding of the concept. If professional development is focused on interactive whiteboards, then the training should take place in a real classroom environment where teachers will have an opportunity to gain knowledge in an environment that they feel comfortable.

Putnam and Borko (2000) also recommend differentiating situated learning with distributed learning when incorporating a new technology into the school environment. Distributed learning refers to the concept that cognition should be distributed over a large group of people who collectively work together to accomplish a specific goal. In the case of interactive whiteboard integration, a teacher should not attend a professional development session focused on the technology behind interactive whiteboards. This type of professional development should be reserved for the school system's technicians and technical specialists at the school.

Bandura's (1977) social learning theory describes the importance in role modeling and how it impacts adults in their acquisition of new knowledge (as cited in Knowles, Holton, and Swanson, 2005). Bandura's theory is important when developing contextually specific professional development training sessions for teachers. Social learning theory is not a behaviorist pedagogical approach to teacher training. Instead, it focuses on the idea that a teacher may not buy into the incorporation of new instructional technology if other teachers perceive that their mentors are hesitant to adopt it. The teaching profession is unique in that teachers work within a self-contained environment as well as a community of like-minded individuals. Integration of new instructional technology needs to be perceived as a positive impact on curriculum development. Administrators and teacher-mentors are vital in determining the success of any professional development. Further, less experienced teachers will model the pedagogical practices that were demonstrated by professors during their time spent in university courses that focused on pedagogical techniques and technology integration (Rosenfeld & Martinez-Pons, 2005).

Stevenson (2004) reinforces the importance of creating professional development sessions focused on the community of teachers within a school. She found that teachers would seek assistance from other teachers before contacting an administrator or technology specialist. Teachers prefer informal collaboration with like-minded individuals. These findings help reinforce the importance of situated learning, andragogy, and principles that are associated with adult learning.

Swan, Kratcoski, Mazzer, and Schenker (2005) conducted a study that placed teachers in a controlled situation that included ubiquitous computing and technical support. The researchers observed and noted the teachers' interactions with technology use, and communications with their fellow colleagues. Once the teachers were removed from the controlled situation, the researchers followed up with the teachers in their classrooms to determine if there were any changes in the teachers' pedagogy. The researchers found that the techniques and practices that were shared during the controlled situation between teachers were being utilized in their regular practice. In most cases, teachers from the control group changed dramatically how they approached and taught content.

Brinkerhoff (2006) also investigated the efficacy of a long-duration professional development program, and its effect on teachers' self-assessed technology skills. The researcher found that the participants' self-assessed skills increased significantly over the course of the first summer session and continued to increase throughout the program. The program focused on providing the teachers with relevant materials that would help them deliver the content in a more efficient way. During the professional development program, teachers would receive direct guidance as they were working through their assignments. Teachers were expected to complete the assignments with the technical skills they were developing, and the materials that were given to them during the session. The results from this study reinforce the notion that if a well-designed content focused professional development plan is in place, teachers' technology skills will increase. This supports the conclusion that Garet, Birman, Porter, Desimone, and Herman

(1999) found that teachers should participate in a minimum of 40-50 hours of professional development before any intervention can be successful.

Knapp (2003) suggests that for a professional development session to be successful, it must include these six characteristics in sequential order. To be successful, the professional developments session must:

1. concentrate on classroom teaching that emphasizes high learning standards and on evidence of students' learning to standard,
2. focus on building teachers' pedagogical content knowledge,
3. model "preferred" instructional practices (e.g., active learning), both in classrooms and in adult learning situations,
4. locate professional learning in collaborative, collegial and generally school based-learning environments,
5. offer rigorous and cumulative opportunities for professional learning over time, and
6. align with reform initiatives. (pp. 119-120)

Knapp (2003) suggests that the six conditions should be implemented together to ensure that a teacher is receiving a well-planned professional development session. The first characteristic fits well in the concept of andragogy, because it places its value on the experience that the teachers bring with them when they enter the training session. Teachers can discuss what they have experienced in relation to the training, and how the training could impact their method of content delivery. For example, a teacher notices that a few students who have a difficult time

paying attention in class responded well to step-by-step directions that were written on the board yesterday. The teacher remembered from a professional development session that the interactive whiteboard has the ability to continuously scroll information at the top of the board. Since the information is constantly repeating, it does not take much space, and the teacher is able to continue with the lesson. In this case, the teacher has learned how to better incorporate technology into the classroom.

Guskey (2000) proposed five characteristics that need to be implemented to ensure a well-designed professional development plan. The evaluation focuses on a series of questions that need to be given to the teachers after they have completed the professional development program. Information is gathered in the area of: Participants' Reactions, Participants' Learning, Organization Support and Change, Participants' Use of New Knowledge and Skills, and Student Learning Outcomes. The first level focuses on the teachers' reaction to the professional development. The questions are focused on the comfort level of the teachers, as well as the relevance of the material. The second and third levels focus on the acquisition of knowledge, and support that was provided to help with the knowledge development. The fifth and sixth levels examine how the teachers apply the new knowledge and skills that they developed, and what effect it has had on student efficacy.

Whether the focus is a formative or summative approach to professional development preparation, the most important element is the regular collaboration of other teachers (Dufour, Dufour, & Eaker, 1998; Penuel, 2006; Windschitl & Sahl, 2005; Stevenson, 2004; Triggs & John, 2004; Wilson & Berne, 1999). Another model that encompasses the characteristics and

concepts of many professional development programs and focuses on teacher collaboration is the concept of professional learning communities. Professional learning communities focus on the environment as well as the regular collaboration with other teachers. Common characteristics that are associated with professional learning communities include: shared mission, common vision and values, collective inquiry, collaborative teams, action based research and orientation, motivation to continuously improve, and focus on impacting results (DuFour & Eaker, 2008).

The professional learning communities model differentiates itself from other models because it is focused on the interaction between teachers, their educational values, and the school environment. This model works well when introducing new technology for the classroom. Teachers can rely on each other for immediate technical and curricular support. They can discuss troubleshooting techniques and best practices because they are all part of the learning community. Another benefit of the professional learning community model is that teachers who are hesitant to try new technologies will feel pressure from the other members to incorporate the new technology into their curriculum. At this stage, technology integration becomes part of the school culture, and the ability to innovate and develop new integration techniques is reinforced by a community of like-minded individuals.

Pflaum (2004) found that once teachers are placed in an environment that reinforces the use of technology, their personal comfort and expertise with the technology increases their ability to develop innovative uses for technology integration. When teachers are in a ubiquitous interactive whiteboard environment, they can more easily develop curriculum that supports the use of technology. They will feel more comfortable because the environment supports the use of

interactive whiteboards and in turn they will be able to develop innovative methods of technology integration and content delivery.

Understanding the importance of innovation, Rogers (2003) developed the innovation-decision process that separates the process into distinctive steps. The innovation-decision process is a general concept for understanding how an individual progresses through the stages of technology adoption to the stages of mastery. The model progresses through five stages. They include: knowledge of the innovation, persuasion to use the innovation, the decision to use the innovation, the implementation of the innovation, and confirmation of the innovation's use and value. The model is broad in its explanation of how users progress through the process of technology mastery. Critics of the innovation-decision process argue that not every user follows a linear path to technology mastery, and the stages of mastery have not been reproducible in similar studies (Sooknanan & Melkote, 2006).

Kotrlik and Redmann (2005) examined how teachers who teach adult basic education adopt new technologies and the path they take to integration. The researchers propose four steps that adults take before they reach expertise in the use of the technology. They include: exploration, experimentation, adoption, and advanced integration. When adults are in the exploration phase of technology integration they exhibit an interest in the use of the technology, and how that technology could impact their teaching methods. The adults then progress to the exploration phase, where teachers begin to slowly implement the new technology in their content delivery. After teachers believe they have an understanding of how the technology works, they progress to the adoption stage. At this point, teachers are using the technology on a daily basis.

The use of the technology is an integral part of the content delivery. They then enter the final step of innovation, where they are using the technology in different ways to meet their goals in and out of the classroom setting.

**Concerns-Based Adoption Model (CBAM)**

The Concerns-Based Adoption Model (CBAM) proposed by Hall and Hord (1987, as cited in Shuldman 2004) suggests that adults progress through seven stages before the use of a new technology is completely integrated into their daily routine. The seven stages include: awareness, informational, personal, management, consequence, collaboration, and refocusing stage.

Adults enter the awareness stage when they first see or hear about a new technology. At this stage, the teacher does not fully understand the technology and is not able to make the decision whether or not the technology could impact content delivery. The next stage is the informational stage. Teachers will research and ask other teachers about the use of the technology. They may visit websites to determine if the technology is widely used and if there are resources available for them to review. After teachers review the information, they will determine if the technology will impact them personally. This includes the processes of determining if the technology will help them teach the content. If teachers decide that the technology is beneficial, they move to the management stage, where they invest time in learning the new technology.

Once the teachers have invested time in learning the new technology, they move to the consequence stage. They begin to reflect on the use of the technology and how it has impacted

their content delivery. If the technology is impacting their classroom curriculum in a positive way, they will continue to use the technology and move to the collaborative stage of technology adoption. The collaborative stage centers on the teachers' excitement about the use of the technology. They become advocates for the technology and offer to share their experiences with other teachers. The final stage in CBAM is the refocusing stage. At this point, the teacher has mastered the use of the technology, advocated its use, and is now actively thinking of other ways of using the technology in the classroom.

With the combination of the right conceptual framework and learning theory in mind, trainers and organizers of professional development sessions can capitalize on the most meaningful and efficient ways to take teachers from distant knowledge of technology through the development of tacit knowledge to full integration in the classroom.

**Conclusions from the Literature Review**

A study of the literature did not reveal evidence that student achievement at any level of education is increased by the application of instructional technology. Instead, researchers have pointed to the complex interplay that exists between the combination of specific instructional technologies and their contextual applications in educational settings (Harris, Mishra, & Koehler, 2009; Desimone, 2009). Researchers have found that a technology application is most effective when it is used as a manipulative tool to enhance a student's understanding of the information in a student-centered learning environment (Koehler, Mishra, & Yahya, 2007; Silvernail & Lane, 2004). Technology applications that do not impact student performance seem to enhance student interest and motivation in the content material, but it is unclear whether or not there is a

relationship between enhanced student interest and motivation and increased learning. Additional research needs to be conducted to determine the best method for integrating instructional technologies into the classroom environment.

A study of the literature did reveal that teachers are the agents of change in the classroom. It is their knowledge, comfort level, and understanding of the technology that has the largest impact on successful technology integration. Adult learning models and technology integrations models have attempted to parse the complexities that exist when integrating technology in classroom. However, research has not identified a single theoretical construct that captures the complexity of technology integration in the classroom. There are a number of barriers that exist when incorporating technology into the classroom. The most significant is how to incorporate technologies into daily curriculum without completely retraining teachers in how to use the technology effectively in their classroom.

# Chapter 3

## Method

The purpose of this case study is to understand how K-12 teachers without prior experience in using interactive whiteboards begin using and integrating interactive whiteboards in their teaching practices. This study originated from a pilot study previously conducted by the researcher.

### Pilot Study

In the Spring of 2010, a pilot study (Beach, 2010) was conducted with three participants using similar methods and procedures as described in this chapter. The participants were initially observed and interviewed when they received their interactive whiteboards and at the end of the semester. Observation data were collected through twenty-hours of non-participatory observations. Data from the interviews consisted of audio recordings of two one-hour sessions, the interview protocol, and descriptive and reflective field notes. The interviews were transcribed and emailed to the participants to check for accuracy, and thick-rich descriptions were created from the field notes to help in evaluating the data for codes and themes (Bogdan & Bicklen, 2007).

The three participants were all from the same school, and taught in the same school system located in the southeastern region of the United States. The participants were the first to receive the interactive whiteboards within the school system. They were selected by the school system's technology director to evaluate the interactive whiteboards, and provide feedback about their effective use in the classroom. The technology director decided not to provide the teachers with

training because of the limited resources that were available. The participants were female, and their ages ranged from early thirties to late sixties. The participants chose their own pseudonyms after the initial observation.

The first participant in the study was Mrs. Northfleet, a first grade teacher in her mid-forties. She described herself as being "somewhat" tech savvy and saw a potential for the use of computers and applications to enhance curriculum. Mrs. Northfleet only used the interactive whiteboard for writing purposes. She demonstrated proper handwriting techniques and letter formation for the first three weeks. After she was more comfortable with the interactive whiteboard, she allowed the students to write on the board as a reward. When Mrs. Northfleet would encounter a problem with the interactive whiteboard, she would only spend a brief moment troubleshooting before shutting the board down and continuing the lesson without it.

Ms. Sampson, the second participant in the pilot study, was a fourth grade teacher in her late sixties. In regards to her technology skills, she described herself as "not" tech savvy, but realized that students enjoyed the use of technology in the classroom and was willing to add more technology to her curriculum. Ms. Sampson only used the interactive whiteboard when she taught science. She downloaded and incorporated several science-related flipcharts from the Promethean website and used them during her science lessons. When encountering issues with the interactive whiteboard, she would turn to her students and ask them for assistance. She explained that her approach was two-fold. First, the students were able to share their knowledge and demonstrate problem-solving skills in a real situation. The second reason accentuated her deep understanding of pedagogy, and her focus on student-centered activities. She explained that

by encouraging students to offer suggestions, she was demonstrating that everyone has an opportunity to contribute to the solution of a problem, and learning is a continual process.

Ms. Ruby was the youngest participant in the study, and had the least amount of experience teaching. She was a third grade teacher in her early thirties and described herself as a technology enthusiast. Ms. Ruby used the board in all of her lessons throughout the study. She downloaded a variety of flipcharts, as well as made her own. In her interview, she explained that the she felt more comfortable using the interactive whiteboard in presenting her lessons. She found the delivery of the content transitioned better when the instructions and information were completely electronic.

Ms. Ruby resolved most of her issues on her own during class. If the interactive whiteboard became unresponsive or would not give the desired result, she would fix the problem within a minute or two. At the beginning of the semester she would troubleshoot a problem, fix it, and move on as if nothing interrupted her lesson. In the later interview, she commented that she would often ask the students to offer solutions to the problems, even when she knew how to resolve them. When asked why she changed her approach, she explained that she spoke with Mrs. Sampson and found that she would ask students for assistance, and realized that it was an opportunity to teach and demonstrate critical thinking skills.

Once the data collection was complete, the researcher used open coding to evaluate and analyze the field notes, observations, and interview transcripts (Strauss, 1987). The researcher then analyzed the data for in vivo codes, and established themes that best represented the codes (Gribich, 2007). Once coding was complete, the researcher displayed the coded themes in a

workshop-style event where other researchers reviewed the in vivo codes and emergent themes. Information derived from the workshop was used to assist in evaluating the codes and themes. The list below contains the themes that were prevalent among all of the participants during the pilot study:

- Each teacher used a different process for troubleshooting.
- The time spent troubleshooting the problem varied tremendously between participants.
- Initially, the participants used the interactive whiteboard solely as a display device.
- The participants who felt the least comfortable with technology blamed themselves for the mistakes. The participants that felt comfortable did not blame themselves for the mistake, but instead blame was placed on the board.

The importance of the pilot study (Beach, 2010) was to develop a foundation for the current study and identify appropriate procedures and methods that best fit the project. For example, the duration of the classroom observations was too long; therefore, the classroom observation time was reduced and centered on more relevant teaching demonstrations. The researcher also coordinated observation times with the teacher to avoid conflicts with testing days and special events. The observations and interviews in the pilot study did not reveal enough information about the internal processes that the teachers took when implementing the interactive whiteboard into their curriculum. This led the researcher to incorporate the use of personal journaling so teachers could reflect daily on their integration of the interactive whiteboards. The pilot study confirmed the current literature and provided a new process of gathering data that allowed the researcher to more adequately answer the research questions.

**Method**

Similar to the procedure employed in the pilot study, in this study the researcher used personal interviews conducted at two points in the semester, as well as research field notes, and the participants' personal journals. Personal interviews were conducted three weeks after the students returned from winter break. The first initial interview lasted one hour and was administered during the teachers' planning period. Teachers were given a 2 gigabyte USB drive that contained a Microsoft Word document designed to be used as a personal journal. It included a self-interview protocol to guide responses to help teachers focus their answers. A copy of the self-interview protocol can be found in Appendix H. Journals were collected, and the interview process was repeated three weeks before summer break.

During the time between interviews, the researcher conducted four observations with each [teacher. The day and time of the observations were coordinated with the teacher to avoid testing conflicts and school events. The duration of the observations varied from 20 minutes to 45 minutes, depending on the age of the children and length of the lesson. A typical kindergarten lesson is 20 minutes long, whereas a high school lesson could easily last 45 minutes. The researcher wrote descriptive field notes during the observation and only focused on the teachers' use of the interactive whiteboards and any pedagogical techniques that were combined with the use of interactive whiteboards. The researcher adhered to Bogdan and Biklen's (2007) and Patton's (2002) definitions of field notes throughout the observation. Descriptive and reflective field notes were maintained throughout the duration of the study.

Participants included three teachers at the elementary level (kindergarten to fourth grade) and three teachers at the secondary level (ninth to twelfth grade). After coding the interview, journal, and observation data, the results were examined through the lens of prevalent theoretical models of technology adoption including andragogy, Concerns-Based Adoption Model, and the Technological Pedagogical Content Knowledge framework, which were presented in Chapters 1 and 2. The objective of this study was to gain insight and inform the educational technological training community about procedures and avenues teachers take when implementing new instructional technologies in their classrooms, and steps they may take when seeking technical assistance. This information could help streamline the training process and better inform trainers, educators, and administrators in technology use and integration.

This study took place in the southeast region of the United States. The participants used in the sample taught in a school system with nearly three hundred interactive whiteboards. The teachers who were selected to participate in this research study taught in a ubiquitous interactive whiteboard environment and had interactive whiteboards installed in their classrooms. The school system benefited from the local university that specialized in technology integration within all of its colleges. The university also recently established a Science, Technology, Engineering, and Mathematics (S.T.E.M.) center that was open to the community and the local school system. The S.T.E.M. center held workshops during the summer for teachers to develop their technology skills in all content areas including interactive whiteboard training.

## Research Questions

1. *How do K-12 teachers without prior experience in using interactive whiteboards begin using and integrating interactive whiteboards in their teaching practices?*
2. *What type of technology training do teachers perceive as beneficial in helping them to use interactive whiteboards in their teaching practice?*
3. *When encountering technological problems that prevent them from fully utilizing the features of their interactive whiteboards, what kind of troubleshooting techniques do teachers use before seeking a technician's assistance?*
4. *Do teachers, at the elementary and high school level, have similar problems with interactive whiteboards and employ similar problem-solving strategies?*
5. *Do teachers, at the elementary and high school level, use interactive whiteboards in similar ways?*

## Setting

This study took place at two locations. The names of the schools have been replaced with pseudonyms. Walnut Elementary School is a kindergarten through fourth grade school located within two miles of the local university. On the school's website the principal's message explained that technology is changing the world around our students. He stated that every opportunity to help a child would be used to ensure the success of each student. Walnut Elementary had a Promethean interactive whiteboard in every classroom.

Walnut Elementary served 375 students of which 71% percent were considered economically disadvantaged, according to the state's 2009 school report card. The demographics

of the school were predominately White (80%), Hispanic (11%), and African American (7%). The physical layout of the school is presented in Appendix F.

The school was originally a log structure built in 1876. Since then, the building was rebuilt with new materials and added new classrooms. The last major construction was completed in 1963. At the time of the study, every classroom had a Promethean board permanently mounted on one of the classroom walls. Each teacher had been assigned a Macbook laptop to use for lesson plan creation and other teacher-related tasks. In addition, an iMac desktop computer was added to each classroom to be permanently connected to the Promethean board. With the addition of the iMac, the teachers' Macbook laptop could be completely devoted to lesson plan development and classroom preparation.

The second location was a large high school located six miles away from the local university. Beech High School was built in 1996 with 400,000 square feet, and served 2,200 students in grades nine through twelve. The academic program was based on a traditional six-period school day. Beech also offered courses in college preparatory, International Baccalaureate, Advanced Placement, technical education, a variety of electives, and dual credit options. The use of instructional technology was ubiquitous throughout the school. Classrooms were equipped with computer stations and projectors or interactive whiteboards. Computer labs were used throughout the building for instructional purposes including credit recovery and online courses. Technologies were used throughout the building and were a vital part of instruction. Students registered for classes online, as well as tracked their grades throughout the semester. Each floor had a computer lab where students had hands-on access to technologies that they

could potentially use later in their careers. While there was an exceptional amount of technology within the school, only the Math department had an interactive whiteboard installed in every classroom. The Math department was split between the first and third floors. A diagram of the high school can be found in Appendix G.

The demographics of Beech High School at the time of the study were the following: 89.8% White, 2.8% African-American, 2.7 % Hispanic or Latino, 5.8% Native American/Alaskan, and 2.0% Asian. The graduation rate was 93% and the attendance rate was 94.9%, with 85% of graduating seniors going on to post-secondary programs.

Parent and family demographics for Beech High School were based upon responses supplied from a parent survey administered by the school. The results of the survey were published on Beech High School's website. Grade level of students whose parents completed and returned surveys were 4% ninth grade, 48% tenth grade, 27% eleventh grade, and 21% twelfth grade. Of those who responded, 28% were single, divorced, or widowed, 65% married or remarried, and 7% separated.

The income levels of parents who responded to the school's survey were: 18% below $25,000.00; 23% between $25,000.00 and $50,000.00; 24% between $50,000.00 and $75,000.00; 19% between $75,000.00 and $100,000.00; and 16% over $100,000.00. Those who responded were 75% White, 11% African-American, 8% Asian, 3% Hispanic or Latino, 2% American Indian or Alaska Native, and 1% Native Hawaiian or Pacific Islander. Of the parents who responded to the survey, 59% had enrolled in college courses and beyond, 38% had a high school education, and 3% completed middle or junior high school.

**Participants**

The selection of participants was conducted with the assistance of the principals at both schools. The principals provided a list of 12 teachers (seven high school, five elementary) who received an interactive whiteboard but did not receive formal training. The principals at both schools indicated which participants would be the most willing to help because of their previous projects during which they opened their classrooms to outsiders, and their continued determination to improve their teaching through the use of technology through professional development and collaboration. From that list, the researcher emailed the teachers and scheduled a time to meet. Of the 12 teachers selected, only six (three high school, three elementary) responded to the researcher's email. Because of outside factors, including the addition of student teachers, new technologies, and other responsibilities, the principals were not willing to provide more participants at the time of the study. Even so, the data collected were rich and detailed, comprehensively answering the research questions of the study. The age of the participants ranged from late 20s to late 40s. All of the teachers who responded were licensed to teach in their current placements and all held advanced degrees. These advanced degrees include Master's and Specialist degrees in Education. Table 3.1 gives specific demographic information about each participant.

**Table 3.1** ***Demographics of Participants***

| Self-Selected Pseudonym | Gender | Race | Age | Teacher's Class Grade Level |
|---|---|---|---|---|
| Whitney | Female | White | 48 | 1 |
| Sandi | Female | White | 37 | K |
| Cindy | Female | White | 28 | K |
| Lilly | Female | White | 42 | 11 |
| Mallory | Female | White | 41 | 9 |
| Steven | Male | White | 44 | 10 |

**Human Subjects Safeguarding**

Participants completed an informed consent form that informed them about the purpose and scope of the study. After the consent form was received by the participants, the researcher met with each participant to answer any questions they had. Appendix C contains a copy of the consent form that was presented to the participants. Pseudonyms were used to protect the identities of the participants.

Research data were encrypted on the researcher's laptop with TrueCrypt. The researcher used an iPad application to record and keep typed notes during the observations. Audio recordings of the interviews were encrypted, backed up online, and secured on the researcher's laptop. The audio recordings were transcribed and emailed to the participants to review for accuracy.

The researcher also adhered to the American Research Association's code of ethics regarding confidentiality and did not reveal any data that will identify a participant or the

school's location. The researcher was the only individual with access to the data. Participants were able to refuse or withdraw from the study at any time without negatively impacting the teacher's professional reputation or relationship with the local university.

**Instrumentation/Materials**

The participants had Promethean interactive whiteboards installed in their classrooms prior to the start of this project. Each participant was given an Apple Macbook laptop from the local school system to use in conjunction with the interactive whiteboard. During the study, the elementary teachers received iMacs that were permanently connected to the interactive whiteboards. Promethean's ActivInspire interactive software was installed on the Macbooks and iMacs. This software was necessary for the teachers to take advantage of the interactive features of the Promethean Board. The researcher used the iPad application SoundNote to record the audio conversations and store the transcribed interviews and transcribed the interviews from each session. Appendices D and E contain copies of the interview protocols.

**Research Design**

The researcher incorporated a case study approach using an ethnographic perspective (Hymes, 1982; Gee & Green, 1998). An ethnographic perspective, in contrast to ethnography, does not focus on understanding an entire culture but instead focuses on the actions of smaller groups (Hymes, 1982; Bloome, 1989). This approach is also used when studying practice-oriented theories in smaller group settings (Ortner, 1984). The case study was guided by the case study structure created by Lincoln and Guba (1985) that starts with the overall problem (how teachers begin integrating interactive whiteboards in their classrooms), the context (interactive

whiteboards in the classroom), the issues (technical difficulties), and lesson learned (development of tacit knowledge).

Creswell (2007) recommends that a case study should only be used when the case has a clear set of boundaries. He also recommends the researcher has a wide array of information about the case, and can provide an in-depth picture of it (Creswell, 2007). Because the researcher was an established member of the educational community, he was familiar with the background and had an in-depth understanding of the case. The installation of the interactive whiteboards without proper training provided an ideal situation to conduct a case study because it gave an opportunity to record how teachers construct knowledge and use new technologies without formal training. Creswell (2007) also recommends that researchers be able to understand the complexity of the case study. Since the researcher has intimate knowledge of teaching practices and technology integration, he is able to see and decipher codes that may be overlooked by other researchers with less experience in teaching and integrating technology.

**Researcher Reflexivity Statement**

As an instructor of Instructional Technology at the local university, and a Ph.D. candidate at the state's flagship university working to complete a degree in the same field, the researcher is interested in what impact technology has on education. Technology provides new opportunities for self-expression and opens communication that is changing the landscape of education. Information that was once hidden securely on the shelves of libraries is now available at our fingertips. Teachers around the world can now communicate with each other in real-time and can access a plethora of information at a moment's notice.

The researcher is a licensed teacher, and holds an undergraduate degree in Secondary Education with emphasis in History, as well as endorsements in Geography and Computer Science. The researcher also holds a Master's Degree in Educational Administration. Because of the researcher's educational background, he has a strong foundation in pedagogical techniques and understands the intricacies of teaching. The researcher was able to understand why a teacher decided to use one pedagogical strategy over another because of his background and experience. Experience at the university teaching Educational Technology courses has given the researcher intimate knowledge of the technology available in the classroom. The researcher has also used interactive whiteboards for several years, and is experienced in both teaching and using the technology. This experience has allowed the researcher to understand the dynamics that take place in the classroom when incorporating instructional technology.

The learning theory that the researcher subscribes to is the constructivist view of teaching and learning. Teachers learn new ideas and ways of teaching through their own experiences with the technology. In contrast to a constructivist view, a positivist view may take the stance that twenty to thirty hours of professional development dedicated to the interactive whiteboard is the proper approach to gain adequate technology knowledge. The researcher has personally experienced that no matter how many training hours teachers participate in, it is only when they get into the classroom, encounter real student opinions, and face the challenges of technology, do they really learn about technology and its best uses.

## Data Analysis

Before beginning the data analysis process, the interviews, personal journals, and field notes were transcribed. The process of transcribing allows the researcher to become acquainted with the data (Reissman, 1993). The interview data, field notes, and personal journals were stored in Microsoft® Word files. All coded data were reviewed through the lens of prevalent theories previously mentioned to build logical explanations and add to the internal validity through the use of comparative analysis with rival theories (Yin, 2003).

The emerging themes were discovered through the process of in vivo coding (Strauss & Corbin, 1998). The researcher followed the step-by-step guidelines provided by Braun and Clarke (2006) for thematic analysis. Themes that were prominent across all cases were documented as well as those that were unique. The guidelines provided rigor but still allowed for flexibility that is often needed in qualitative data analysis. The guidelines were: (1) familiarize yourself with the data, (2) generate initial codes, (3) the researcher reads each transcript to immerse himself in the data, (4) analyze the themes, (5) define and name the themes, (6) produce the results (Braun & Clarke, 2006).

## Data Verification

To ensure the credibility of the data, the researcher incorporated a variety of validation strategies. Qualitative researchers utilize a variety of validation strategies to make their studies credible and rigorous (Creswell & Miller, 2000). Credibility and validity for this study was achieved through the validation strategies of triangulation, thick rich description, researcher reflexivity, and peer debriefing. Triangulation was achieved though the collection of interviews,

reflective journals, and field notes. The researcher also incorporated Stake's (1995) "critique checklist" to analyze the case study quality. This checklist contains 20 questions to assess the quality of a case study report. A copy of the checklist is included in Appendix I.

**Procedure**

As described in the participant section, the teachers were recruited with the assistance of the principals at both schools. The principals provided a list of teachers that they thought would be interested in participating in the study. The principals were able to give feedback about which teachers performed well with the use of technology, as well as teachers that showed signs that they were struggling with the use of technology. The researcher contacted each participant and discussed the procedures with the teacher two weeks before the study began. This gave the participants an opportunity to ask questions and address any concerns about the study.

The personal interviews were conducted three weeks after the students returned from winter break. The first initial interview lasted one hour, and was administered during each teacher's planning period. After the interview, the teachers were given a 2 Gigabyte USB drive that contained a Microsoft Word document designed to be used as a personal journal. A copy of the reflective journal template can be found in Appendix H. The teachers were asked to reflect on their experiences with the interactive whiteboard each day, how they went about troubleshooting difficulties that they encountered, and who was involved in the process of finding a solution to the difficulties.

The researcher conducted four non-participator observations with each teacher. The day and time of the observations were coordinated with the teacher to avoid testing conflicts and

school events. The duration of the observations varied from 20 minutes to 45 minutes. The observations were only focused on the teacher's use of the interactive whiteboard and any pedagogical techniques that were combined with the use of interactive whiteboard.

Field notes developed from the observations were used throughout the research process. After the first interview, the researcher began analyzing interviews and observations for developing themes that emerged from the data. During the last weeks of school, the second interview was conducted and the themes that emerged from the data were compared and examined.

**Conclusion**

Qualitative research was used to investigate how teachers without prior training integrate and implement interactive whiteboards into their teaching practice. It investigated the relationships teachers build with each other and the complex interplay of knowledge acquisition and technology integration. The research questions were investigated in the study using the methods, procedures, and analysis described in this chapter. The researcher has extensive experience in interactive whiteboard implementation and played a vital role in the analysis and interpretation of the data. In the following two chapters, the researcher will describe, analyze, interpret, and present the data collected during this research.

# Chapter 4

## Findings

This chapter discusses the major themes that were identified during the analysis of the data. The first section provides relevant background information about each participant, including the participants' teaching history, content area focus, and general perception of technology use both in and out of the classroom. The second section addresses the research questions along with a presentation of data organized into themes and categories. A summary of the findings concludes the chapter.

Participants' backgrounds were included to help provide insight into some of the avenues participants took to implement the interactive whiteboard into their daily teaching. Participants' ages ranged from late-twenties to late-forties. All of the teachers who participated were licensed to teach in the area that they were teaching, and all held advanced degrees. The advanced degrees included Master's and Specialist degrees in Education. Each participant had a minimum of three years' teaching experience before receiving an interactive whiteboard. Two of the participants were required to take a course while pursuing their undergraduate degree that was designed to teach teachers how to incorporate technology into the classroom. The other participants did not have a course that focused on technology integration while they were pursuing their undergraduate degree because such a course was not available at the time in their programs of study.

## Participants' Background

The participants' comfort level with technology varied, but all were eager to use the interactive whiteboards in their classrooms. The majority of the participants described their skills with technology as adequate. Lilly was the only participant to identify herself as having advanced skills in technology. Sandi described her skills as adequate, but all of the participants at Walnut Elementary compared their skills to Sandi's. Statements like, "I'm pretty good, but Sandi is a natural" and "She [Sandi] has a knack for it [technology]" were used in conversation. The following section offers a brief profile of each participant.

### Sandi

Sandi, a kindergarten teacher for 16 years at Walnut Elementary School enjoys using computers and gadgets at school and at home. She said, "It's something that my husband and I both enjoy." Sandi's husband was recently promoted to director of technology for the school system. She explained, "My husband and I always loved gadgets and such. We are always watching and waiting for the next big technology to drop, and we enjoy reading about how technology has impacted our life and the future of education." Sandi enjoys the use of technology and believes that it has and will have an enormous impact on student education. The principal of Walnut Elementary selected Sandi to be the first person to attend training in the use of the interactive whiteboard. Through casual conversations with the other participants and the principal at Walnut Elementary School, they all agreed that Sandi was the most tech savvy of all the teachers within the school.

**Whitney**

Whitney, a first grade teacher for 22 years at Walnut Elementary School enjoys using interactive whiteboards. She explained, "I love the interactive whiteboard. I can show websites and worksheets that I find on Google." She further stated, "I don't consider myself a guru when it comes to technology, but I use it when it is in my classroom." Whitney wishes that she had a technology integration class when she was pursuing her undergraduate degree. She sees the value that technology can offer her students, and is willing to deal with minor technical difficulties that occur when she is learning how to use a new technology. Her perception is that computers, interactive whiteboards, and the Internet are tools that can be used to enhance curriculum. She does not consider them to be sources of entertainment.

**Mallory**

This is Mallory's third year teaching Geometry, Technical Geometry, Algebra 1, and Algebra 2 at Beech High School. Of the participants, she has the least amount of experience in teaching because teaching is her second career. She was formerly a mechanical engineer and decided that she needed a career that she felt was more rewarding. She returned to the local university and enrolled in a program that encourages undergraduate degree holders in the fields of Math, Science, and Technology to pursue a teaching license. While comfortable with Windows-based PCs, she felt overwhelmed when she started teaching at Beech High School because they only use Apple computers. She believes that students should have open access to computers, and that access and understanding of technology is essential for a proper education.

Mallory benefited from a course that specifically focused on technology integration while she was pursuing her teaching license. “The class was really helpful. We didn’t have a lot of time to work with the interactive whiteboard because I took the two week modified version of the course during the summer.” She did explain that the professor provided a lot of content and videos that could be used later. This was his attempt to accommodate for the short course meeting time, but Mallory could not remember the website to access the information. Mallory believes that the Internet should be treated as a utility, like water and electricity, and everyone should have equal access.

**Lilly**

Lilly also teaches in the Math department at Beech High School. She teaches advanced placement Calculus and Algebra I. She identified herself as a tech savvy teacher, and also considers herself to be the first resource teachers go to when they have technology issues. Before teaching at Beech High School, Lilly taught at a school located in a rural area of the state that did not have access to interactive whiteboards. The school where she taught only had a limited number of calculators, which she explained made it difficult teaching mathematics. While she thinks that technology is important to enhancing the curriculum, she believes that she could teach successfully without it because of her prior experience of not having access to technology. Lilly has taught for Beech High School for 12 years, and enjoys the use of technology both in and out of school.

**Cindy**

Cindy, who previously taught sixth grade English, just finished her first year as a Kindergarten teacher. This is Cindy's fifth year teaching and her first opportunity to use an interactive whiteboard. Moving to a new grade, and learning how to use an interactive whiteboard has been difficult for her. She explained that at times she felt overwhelmed because she was trying to plan for new content and incorporate the whiteboard at the same time. Cindy is the youngest of the participants, and also benefited from taking courses that discussed technology integration in the classroom when she was pursuing her undergraduate degree and teaching license. She explained, "I learned a lot about how to use the board in my technology class in college. I didn't really quite understand how it all connected. I just went through the motions." Cindy explained that the board was discussed, but she never actually worked with the software or used the software in conjunction with the board. Outside of the classroom, Cindy enjoys using the Internet to search for information for lesson development and keeping up with her other teacher friends on Facebook.

**Steven**

Steven is head of the Social Studies department at Beech High School. He has taught history for 11 years and considers himself technically adept but does not enjoy using computers regularly. Steven believes that technology is important and should be used in the classroom. He believes that computers are a good productivity tool, but are often distracting and time consuming for his students, making them a necessary evil. Steven explained, "I hate how technology always demands your attention. It's always buzzing and beeping and pulling you

away from what you are invested in." Steven uses both computers and his interactive whiteboard at school and incorporates them into his daily teaching. He claims when he is away from school, he very rarely uses technology, explaining that he does not check his email or surf the Internet and does not regularly check his cell phone. Steven understands the power of technology and its importance in the classroom, but believes that there is a time and a place for its use.

**Themes from the Data**

Braun and Clark's (2006) model for thematic analysis was used to process and identify themes and categories in the interview transcripts, personal journal reflections, and observation field notes. The process involved the researcher reading the data several times to code patterns and develop themes. Themes from the data were used to answer each research question. The research questions are addressed in the following sections with findings from the themes and categories that relate to each research question. The themes helped to understand how K-12 teachers without prior experience in using interactive whiteboards begin using and integrating interactive whiteboards in their teaching practices. Four themes and eight subthemes were identified. Table 4.1 describes each theme and subtheme along with the definitions and categories identified within the data.

**Table 4.1** ***Themes, Subthemes, Definitions, and Categories Identified in the Data***

| ***Themes/Subthemes*** | ***Definition*** | ***Categories*** |
|---|---|---|
| **Types of Training** | Three types of teacher training made available to teachers throughout the school year. These trainings taught teachers to use their interactive whiteboards, troubleshoot, and explore features. | computer-based training<br>professional-based training<br>colleague-based training |
| **General Use** | Participants found several ways to use their interactive whiteboards. Some used them only as they were marketed, and some found more creative ways to integrate them into the classroom. | projection<br>websites<br>whiteboard<br>software tools<br>hardware |
| *Time* | The time participants used the interactive whiteboards varied. | constant<br>periodic |
| *Technology Beliefs* | Since participants had different histories with technology, teaching, and pedagogy, they each had different views and beliefs about technology and its use in the classroom. | student engagement<br>delivery of content<br>vocational relevance |
| **Technical Difficulties** | The difficulties experienced by teachers that prevented them from using their interactive whiteboards effectively. | |
| *Computer Connectivity* | The connection between the computer, software, and hardware was sometimes problematic. | peripherals<br>screen projection<br>hardware recognition |
| *Software Issues* | Participants used the Promethean software ActivInspire similarly and encountered similar problems. | software migration<br>inefficient software |
| **Problem Solving Techniques** | Teachers used four major techniques to solve technical problems and learn of practical uses for their interactive whiteboards. | |
| *Proximity* | This refers to the participant's use of neighbors for technical assistance. When teachers would experience technical difficulties they would contact the closest teacher for assistance. These teachers would often be close friends outside of school. | friends<br>first person I see<br>hall duty<br>teacher next door<br>bus duty |
| *Peer-Sourcing* | When faced with technical issues that were not resolved by common troubleshooting techniques, teachers would source the problem out and work together to solve it based on each person's unique experience with the interactive whiteboard. | communication through iChat<br>discussing problems with principal<br>discussing problems with department head<br>discussing problems with mentors<br>word of mouth/chat list/email |
| *Prior Knowledge* | How the participants solved problems depended on the problems they had encountered in the past and the exposure they had to other forms of similar software and hardware. | Apple OS9<br>previous software<br>PowerPoint<br>Windows PC |
| *Trial and Error* | This theme refers to the common steps that teachers would take in trying to solve their problems. The steps were not consistent with each participant, but they implemented the same techniques when attempting to solve the problem. | reload webpage<br>unplug and re-plug cords<br>monitor and projector settings<br>screen resolution<br>restart software<br>restart computer |

## Research Questions and Findings

The following sections are organized by the themes established from the researcher's data, and will address each specific research question. The answers to the primary research question, *How do K-12 teachers without prior experience in using interactive whiteboards begin using and integrating interactive whiteboards in their teaching practices?* are embedded in the themes and categories that relate to the other research questions. The researcher will discuss the primary research question and its connection with current research in Chapter Five.

In the presentation of the data, the researcher chose to use as many excerpts from the transcribed data as possible. This was an attempt to allow the reader to understand the participants' situations and the process that teachers took when to making the transition of integrating interactive whiteboard into their daily practice.

### Types of Training

To compensate for the lack of comprehensive training, the school system offered training sessions that were held at various times throughout the school year. Professional trainers and school colleagues conducted training sessions that focused on the various levels of interactive whiteboard use in the classroom. These sessions ranged from basic operation to class examples of interactive whiteboard use. An email was also distributed to teachers to inform them of computer-based training and resource materials that could be used for self-directed learning.

This section is organized around the three types of training the school system provided for interactive whiteboard use. They include computer-based training, professional-based training, and colleague-based training. Because of the large number of interactive whiteboards

that were distributed throughout the school system, a large number of teachers within the school system were not able to attend training sessions before using the interactive whiteboards. The types of training used and discussed by teachers address the first research question, *What type of technology training do teachers perceive as beneficial in helping them to use interactive whiteboards in their teaching practice?*

**Computer-Based Training**

All of the participants engaged in some type of computer-based training. This training was used to help familiarize the teachers with the basic functionality of the interactive whiteboard. Flash-based programs provided by Promethean were used to develop the teachers' basic skills. Teachers were also provided with a handout that guided them through the process of creating an account on Promethean's website, as well as information about searching through the Promethean forums. The researcher has also coded the use and description of technical "cheat sheets" that were distributed by the school system via email as a computer-based mode of training.

The majority of participants reported that using the Flash-based training was of little benefit to them. The tutorial required the participants to master a certain set of skills before moving on. Each skill set was needed to complete the next set of tasks. The training also included a comprehensive test that required a grade of 90 or higher to move to the next section. Only half of the participants in the study finished the tutorial; the other half believed that it was a waste of their time and decided to search for videos and other web pages that focused on what they considered relevant uses of the interactive whiteboard. Each participant described relevant

information as information that was closely related to the grade level and subject area that they taught.

Sandi started the Flash-based training, but decided not to finish. She explained, "When I first started going though the modules I was excited. Then it became boring and repetitive." Sandi, who enjoys using technology, and is confident in her skills, noted that the tutorial was too elementary. She said,

> Once I made it through the first two modules, I thought to myself, "I can figure this out on my own." I started looking online for videos of other teachers using interactive whiteboards in the classroom. I really get a lot of great ideas by watching other Kindergarten teachers on YouTube and reading websites… I see a teacher doing something I like and modify it to fit what I am teaching.

Sandi used the Internet to gather ideas for her classroom. When asked how she developed skills in actually using the interactive whiteboard she explains, "I just fool with it. I get here [to school] early and spend time working on it before students get here. I also make sure that my flipcharts work the way they are supposed to before I begin teaching." She continued by saying, "If I run across something that I don't know how to do, or if something goes wrong I will go online and see if there is a video or website that talks about the thing I am looking for."

Sandi also discussed the use of the cheat sheets that were distributed via email. She explains, "Yeah, they were great! I referenced them quite a bit at first. Then I became more comfortable with the board and I used it less." She continued by saying, "Everyone loved the cheat sheet, I know some teachers even laminated a copy and still keep it on their desk."

Whitney expressed a different view on the Flash tutorials. She found the tutorials informative and engaging. In describing her experience with the Flash tutorials she said, "I really enjoyed them. I liked that I could go at my own pace." Whitney thought the Flash tutorials were challenging to her because she had to demonstrate the skills that she had just learned before moving to the next module. She explains, "I'm not terrible when it comes to using technology. I know that I'm not the best. There are a lot of teachers in this school that are very tech savvy."

Whitney was dedicated to improving her ability to use the interactive whiteboard in her classroom. She acknowledged that she lacked some of the skills that other teachers possessed when incorporating technology into the curriculum. To help improve her ability to use technology, she indicated it as a professional goal in her future growth plan. She explained,

> Our principal is very focused on future growth plans. He wants to make sure that we are striving for goals that will improve our teaching. My professional growth plan for this year was to become comfortable with the Promethean board and other classroom technologies…I'm working to accomplish these goals by attending as much training as possible and searching the Internet for resources.

Whitney also indicated that she used Promethean's website to find resources for her lessons. She explained, "One of the neat features about Promethean Planet is they have flipcharts that you can download for free. Some of them you have to pay for, but I only downloaded the free ones." When asked about any other resources that she used to help with the board she described the cheat sheet that was distributed at the beginning of the year. She indicated that she

used it so much at first that she had to print off another copy because the original was too worn to use.

Cindy also described using the Flash training module in preparation for her interactive whiteboard. She explained, "I didn't have a Promethean board when I taught sixth grade English at the other school. When I knew I was moving to Kindergarten, I looked online for training videos and such." Cindy found the training modules on the Promethean website as well as other videos online. She described her experience with the training modules as "boring" and "frustrating." She explained, "The training was not very user friendly. I couldn't skip around. I had to move through one, which I had already figured out, to the one I was really wanting. That was annoying." She continued by saying,

> Oh, you also had to click on a certain items within the video. It was helpful at first, but sometimes the video wouldn't respond…if you were taking the required test and accidently chose the wrong answer, you were in trouble. You might as well just start over again because you can only miss like one of the questions per test. And to make matters worse, one time [Internet] Explorer crashed on me and I had to start all over again. After that I stopped using the online Promethean trainings.

Cindy also discussed how she was apprehensive about the Promethean board before she even received it. She stated, "There were rumors that you were not supposed to do something a certain way or the bulb would go out." Cindy explained that there were a lot of "little things" that she did not know until she heard it from a fellow teacher. When asked if she searched online for some of the questions she had, she stated, "I didn't. I just followed what the other teachers were

recommending." When asked if she used the cheat sheet that was emailed to all of the teachers she responded, "I didn't look at it. I saw it in my email, but I don't get to check it 'til the end of the day and by then I am tired. I guess I overlooked it."

Mallory benefited from training at the local university while she was pursuing her teaching license. She was able to view the software for the interactive whiteboard prior to receiving one in her own classroom. She explained, "It was a summer course so we moved really fast. We covered a bunch of stuff, but I remember looking at the board in class." Mallory did not have an opportunity to develop interactive flipcharts in the summer course. She described the flipcharts that were discussed as "very basic." Mallory continued, "Some of the flipcharts focused on Algebra skills. The professor did have videos that he had made to help understand the software."

Mallory learned about the Flash tutorials from her college class. She explained, "the professor spoke about the tutorials, but I figured that I could get all I needed from this class." After receiving her board, Mallory searched for the Flash tutorials on the Promethean website. She described her experience, "The tutorials were okay I guess, a little redundant but I finished them. I even printed out my certificate of completion (laugh)."

Steven also participated in the use of the Flash-based training, but quickly lost interest in it. He explained, "When I first started the training I thought, okay, this isn't bad. Then it became ridiculous. You had to click objects that were hard to see and you couldn't move around…" Steven was only able to make it past the first training stage. He commented that he felt that it was too "rudimentary" for him. He further explained, "I got to the end of the first stage and

started taking the test. Once I finished, the next set of questions came up. I looked up at the clock and it took me almost an hour to finish the first session. It was a waste of time. I felt that I could do better on my own."

Lilly's reaction to the Flash-tutorials was similar to Steven's reaction. Lilly also commented that the tutorials were too basic in nature and were a waste of her time. She explained," When I started the tutorial I automatically knew that this was too easy. It wasn't for me. I knew I could just figure it out on my own." Lilly, like Steven, did not finish the tutorial. She stated, "I guess I made it halfway though. You know…I really don't remember how far I actually got. I didn't spend to much time on it, I know that."

**Professional-Based Training**

Mid-way though the term, the participants were able to attend an optional professional training session held by the interactive whiteboard installers. The cost of the training was covered by the original cost of the interactive whiteboards. The training was a lecture-based session where teachers followed along with the presenter. There was an average of 30 participants within each training session. The session was not separated by grade level or content area.

The reaction to the professional training was overall positive. A few of the participants commented that they enjoyed the session. One the participants attended the same session twice to build her skills. The professional training covered the basic functionality of the board. Mallory explained her experience at the professional training:

> The training was wonderful! The lady from Promethean focused on the basics of the boards and how to use them. The only problem was that you were bombarded with all of this information. And you think to yourself 'okay I got this.' Then you walk away and you think, 'oh my goodness! How am I supposed to remember all of this information?'

Despite the fact that the training was held during the school year, the participants commented that they were overwhelmed with the amount of information that they were given at the training session.

During the professional training, the teachers were given a laptop that was similar to their school laptop to use for the session. Steven explained,

> The Promethean woman seemed like a master with the board. Even though at times it felt like a sales pitch, she was still very good. Now that I think about it, it was one of the most dynamic trainings that I have been to. Most of our teacher trainings are pretty lack luster. She taught a lot of the basic tools. It was nice. We didn't actually touch the board during the training. We just used our laptops with the software installed. That was good enough for me.

Steven noted that he would have benefited more from this professional training if he was with others who taught the same grade level or subject area as him. He explained, "I thought we wasted a lot of time in the training talking about how to draw little pictures, and how to add coins together. They [elementary teachers] have a whole set of issues different from us." He admitted he thought elementary teachers were more hands on with their board use. Steven explained, "I think they have a lot more time in class to use the board. I have six periods that only last for an

hour. It's difficult for me to bring them up to the board and cover the material at the same time." Steven commented that separate training would have benefited both groups of teachers.

Whitney elected to participate in the professional training twice. She explained, "When I sat through the first training it all went over my head. So I took a personal day and trained again." Whitney commented that the second training really helped her understand the basic concepts that were being presented. She also commented that she felt embarrassed to ask questions during the training. Whitney explained, "There were so many people in the training. I didn't want to be the one that held up the progress of the session." Even though she participated in the session twice, she believed the session was what she needed to help her feel more comfortable using the board.

Sandi also believed the professional training was worth her time. Sandi's husband was the person responsible for bring the trainer back so she could present to more teachers. Sandi explained, "Some of the teachers felt that they missed out on a lot important information by not going to the training. Then again, some said they didn't mind missing it." Sandi had mastered many of the skills that were presented in the session prior to attending it. She was drawn more toward the actual application of the board in the classroom, and how it could be used to teach content. She explained, "When we first got the board, myself and other teachers used it like an overhead. I knew there was more potential for the board than just an overhead projector."

Sandi and a few of the teachers in her school had mastered the basic functionality of the board. She was more interested in the software applications and software tools that came with the board. Sandi explained, "The trainer did a great job, she covered the basics and sprinkled in bits

of content-related information. I looked around, and many of the teachers really responded to that. There was a lot of head nodding when she spoke about teaching content."

When Lilly attended the professional training, she found that she had already mastered many of the techniques that the trainer discussed. She explained, "At first I was really excited to go. I quickly found out that the session just covered things that I had already picked up." Lilly, who considered herself to be tech savvy, found that she quickly outgrew the basic training. Lilly further explained her training experience:

> The training was a mixed group of teachers. There were teachers from elementary, middle, and high school there. I would have really liked to have participated in a session that was only focused on high school teachers. I found it difficult to focus on the training when the elementary teachers were asking questions about students interacting with the board. They wanted to know about kid-friendly features and the big button mode. Those were features that I didn't really care about.

Lilly further explained why she thought that the professional training should be separated into grade specific groups: "I have 35 students in my classroom. I can't let them all go up to the board and draw on it. It's just not possible. Plus, the way my classroom is situated because of the board, they would be tripping all over each other to get there."

**Colleague-Based Training**

A few teachers held local training sessions after school. These sessions were voluntary and focused on practical uses of the board in the classroom. The trainers held the training sessions in their own classrooms. Attendance was voluntary, and the attendees did not receive

professional development hours. Of the research participants, four out of six attended the sessions, but none of the research participants led a session.

Cindy found the local training more beneficial than the professional training session. She enjoyed the small group setting and was interested in developing techniques for interactive whiteboard use for Kindergartners. She attended a local training session by a first grade teacher at another school. Cindy explained, "I was searching for fun ways to deliver information to the Kindergartners. I really had to rethink my approach to a lot of in-class activities. I really wanted to see what the Promethean board could offer a Kindergarten teacher."

Whitney noted that she also benefited by participating in the local training session. She stated, "I gathered a lot of good tips from the trainer. He gave us a lot of useful flipcharts." Whitney was more willing to participate and ask questions in a smaller group setting. She explained, "I didn't mind asking questions there. I knew the other teachers, so I felt more comfortable." When asked if she preferred the local training to the professional training she responded:

> They both have their place. I think if I had gone to the local training only, I would have missed out on a lot of the basic skills. The Promethean trainer really focused on the basics of the board. You know, how to turn it on and off, where the toolbars are located, you know stuff like that. The local training was more focused on how I could use it in the classroom. I really enjoyed that.

Sandi believed she benefited from the local training. She was able to adapt some techniques and apply them to her Kindergarten class. She explained, "The session was really

focused on first and second grade. I still enjoyed the session. I picked up a lot of new ways of using the board."

Mallory, who is a high school teacher, decided to attend the session as well. When asked why she decided to participate she explained: "I'm still working on my board techniques. I don't know. I think I really wanted to see how elementary teachers used the board. How they managed the students when using the board." Mallory explained that she was more focused on developing classroom management skills with the board, instead of learning how to create and connect the content.

In response to the research question *What type of technology training do teachers perceive as beneficial in helping them to use interactive whiteboards in their teaching practice?* participants commented that both the professional and local training sessions were beneficial to their understanding of the interactive whiteboard. Each training session filled a specific role in their integration of the interactive whiteboard. Of all of the training sessions, the computer-based training session was considered the least desirable. The complaints included lack of flexibility, unnecessary steps needed to complete the section, and the modules were not challenging.

**General Use**

How teachers used their interactive whiteboards helped to answer the fourth research question *Do teachers, at the elementary and high school level, use interactive whiteboards in similar ways?* Interactive whiteboards gave the participants a variety of functions that could be used in the classroom setting. The interactive whiteboards not only provided the teachers with interactive elements, but also provided a large viewing surface for displaying media, sound, and

materials. There were several ways both elementary and high school teachers used their interactive whiteboards, including projection of the screen and sound, interacting with websites, writing as a whiteboard, and specific software tools.

**Projection**

All of the participants utilized the interactive whiteboard as a device that projected information on the display board. Some of the participants used the boards as projection devices without using the interactive capabilities. All of the participants used their interactive whiteboards to demonstrate computer applications or connect to a DVD player to display video, images, and sound for the students. Cindy explained, "I use the Promethean board for everything. Music, videos, websites, you name it. I use it. During our music time I will use it to play iTunes for the students to listen to."

Mallory allowed her students to use the interactive whiteboard as a large television to play a video game in her classroom. She explained, "Beech High School sponsored a weekend math camp. All of the math teachers participated. When the students were not working on math related projects, I let them connect an Xbox to the Promethean board and play RockBand." Mallory also allowed students to come to her room and listen to music during their lunch period. She explained, "One day they asked if they could listen to Pandora Radio. I told them that they could only choose stations that played clean music. Are you familiar with that program? I love it. I let them listen to music while they are working on their assignments." When asked why she allowed them to listen to music during their lunch/study time she explained,

I wanted the students to feel comfortable in the room. I wanted them to think of this as their home. Really, it is just an easy way for me to help them with their math homework. But they don't see it that way. Hey, whatever works, right?

The use of the interactive whiteboard as a projector of images and sound had both academic and social implications in Mallory's classroom.

Steven used his board to project maps from the Internet and PDF files that he collected. He also showed videos by connecting a VCR/DVD player to the board. He explained, "My first period is a humanities class. There is a lot of art history in that class. We look at slides on it…it's really more like a blackboard with flashy lights and it has pictures and maps that come up automatically."

**Websites**

The participants utilized the interactivity of the boards to interact with software and visit websites on the Internet. All of the participants used websites on their boards to enhance their teaching and enrich their content delivery. Two elaborated more about the sites they used.

Mallory searched for ways to review and prepare her high school math students for college entrance exams. She explained, "I pull up an ACT question each day from a high school website. They have them everyday. It's an interactive site where they show the solution and they can hear a teacher work through the problem. It's a wonderful website."

Cindy used the interactive whiteboard to keep her Kindergarten students entertained and learning at the same time by incorporating websites from their favorite TV shows. She explained, "In the afternoon I will pull up a game on PBS kids. The kids come up and pick a game to play.

They love Curious George and things like that, and they use it." She also used Starfall.com, a website that is geared toward small children and is focused on reading and phonics development.

**Whiteboard**

Three participants, the three high school teachers, indicated that they sometimes used their interactive whiteboards in the same way they would use a traditional dry erase white board. Mallory said, "I type a lot of things to get ready but when I am up here I just write and draw on the board like I used to on the dry erase board." It seemed natural to Mallory to continue her teaching style of writing on the whiteboard even when she had more interactive capabilities.

Lilly agreed by saying, "mostly its main capacity for a lack of a better term is a glorified overhead. It has much greater capabilities than just being an overhead, but the time to set all of those things up doesn't balance out just yet." While Lilly noted that it was similar to an overhead projector, she implied that she understood the interactive whiteboard's ability to give more functionality than simply a marker and board.

Steven echoed their thoughts, "I pretty much give 80% of my notes on the Promethean board; I typically just write them as I go." An advantage to giving notes on the interactive whiteboard is the ability to save the notes to provide them to students who missed and to prepare for exams rather than having to copy them from the board.

**Software Tools**

All of the participants used the Promethean ActivInspire software with their interactive white boards. The ActivInspire software gave the participants the ability to create flipcharts, or

files with multiple pages that include animated objects and subject-specific tools. Mallory described her favorite math tools:

> My favorite features – I love the grid background, I use objects a lot, I mean it is geometry so of course I do…I use the grid, calculator, and protractor. That's what I really use. You know the compass is nice but since we can use the shape tools to make shapes it is not necessary…I have used some more of the math tools. I have used the dice when we did probability. I pulled up some different backgrounds and rotation as well as dilation and this does all of those things and it will flip over the X axis and the Y axis…I think it is valuable. They need to be able to do them. I use the protractors and compass, shape templates, and rulers too.

Mallory was able to quickly enhance her classroom instruction by being able to model and demonstrate the math tools for her students in real time.

Lilly used the flipcharts in a variety of different ways. She admitted to finding, modifying, and using flipcharts:

> A lot of times I will have to modify them because they are state specific, they are using their own standards not applicable [to our state] but they are a good basis for creating a new flipchart that doesn't take quite so long. As long as someone has done something similar and posted it, you can use it.

Lilly elected to use what was already made and modify it to her needs rather than starting from scratch. She also incorporated a flipchart as a classroom management tool. She combined an idea

that another teacher was using in her class with the flipchart program to make an interactive attendance page. She explained:

> I used that model idea off one of the other teachers that does that with paper and pencil. She had a grid for a week and they come in and check their name off when they walk in the door. When the bell rings she grabs her paper and looks for who didn't check and make sure they are not actually there and can quickly take roll that way…I thought we could put these two together to a more high school friendly setting.

Lilly's attendance flipchart gave her the ability to manage attendance for classes of 30 to 35 students every hour.

Steven used the software and resources he found online to teach his high school history class through more interactive sources. He explained, "There are a lot of possibilities with maps, charts, and graphs…I have found maps that show the movement of armies and wars and stuff on the computer, classic military maps and stuff like that."

Cindy used flipcharts that she learned to make in a local teacher-led training session. She brought them back to her classroom to teach her kindergarteners. She recalled:

> They showed us how to make a money flipchart. We went and found the coins and set up the background. There were like these caves that were a picture and we would pull the coins from places and we had to sort them into different areas. The coins were hidden. There was another one they showed us, like animals 'are they on land or are they on water?' we had to sort them that way.

She was able to immediately integrate these flipcharts into her classroom. Cindy also reported downloading other flipcharts from Promethean Planet and adjusting them to fit the needs of her students so she could use them in her classroom.

Sandi took a different approach to flipchart development. Rather than downloading all of her flipcharts, she said, "I pretty much make my own, but then again I have downloaded a lot and tweaked them to fit my need. I don't want to reinvent the wheel." Being able to create and borrow allowed her to get exactly what she needed for her class and also save time.

Sandi, considered to be tech savvy by the teachers at Walnut Elementary, also used the advanced tools that are available in ActivInspire:

> I use a lot of the tools in ActivInspire. I use actions a lot. I use the action feature that allows the pen to move objects. The kids love pulling objects from behind other objects. We are practicing addition right now so I have a picture of dice and when they click on it, the dice will roll and they have to answer the question…one thing I learned at the training was magic ink. I knew about magic ink, but I had not used it. I have tried to incorporate that.

Although not every participant was able to use the software tools with ease, Sandi, was able to use them and incorporate them into her daily curriculum.

Whitney organized the flipcharts she used by subject area. She used flipcharts that she downloaded, made, and borrowed from other teachers to review her weekly reading skills and stories and to teach her daily math lessons. Whitney explained, "We have a math CD that goes with our curriculum and we actually use it with our Promethean board." Since first graders at the

beginning of the school year are often distracted and not able to do work independently, Whitney asserted, “they are all over the page and it is really hard for them to even try to know where we are so if you put in the CD and use the overlay feature on the Promethean board, it is really helpful for them.” The software and interactivity of the board allowed Whitney to demonstrate lessons in a visually appealing matter.

Whether using flipcharts that were downloaded, made, or shared, or simply using the interactive tools that accompanied the ActivInspire software, the participants were able to use the software to display and teach the required content.

**Hardware**

Along with the interactive whiteboards, the school system purchased hardware accessories to enhance the teachers teaching experience with the interactive whiteboards. The hardware included ActivSlates, ActiVotes, and ActivWands.

Of the participants, Lilly was the first to utilize her ActivSlate. Her quick utilization of the ActivSlate came more from necessity than her overall desire to use the device. She explained,

> In this room, this board mounted on this wall cuts out three feet deep of space for teacher, board and stuff. Since it’s mounted on here and the door is back in the back, I have three feet cut out of the backside. So simply to get all of the chairs for up to 35 students, which last year I had two classes of 35 and all the rest of them were over 30, it was very difficult to do the layout properly. I can’t get back and forth to the board without major disruption, so I use the slate more often and that is a big learning curve…the board itself

could be done away with if I had a projector and the Promethean software and ActivSlate. I could move the projector to any place in the room that is most convenient.

Lilly was able to utilize her ActivSlate to enhance her classroom management and allow access to the interactive whiteboard with such large classes.

Sandi was still deciding how best to use her ActivSlate. She explained, "We all got them three weeks ago. I am still trying to figure out how I want to use it in Kindergarten." She commented that she explored her options online, and examined how other people were using them in Kindergarten.

Although Whitney's slate had been out for repair during the final interview, she recalled how she used the ActivSlate while it was working. She said,

> As far as the slate goes, I was able to do anything with the slate that I could do at the board but I could just be anywhere in the room. So, if we were working, whether it be on a flipchart or on that specific math lesson for the day, I could move around the room. I was able to help children independently. Yet they could look at the board and I could point where we were at. It just allowed me to interact more with them. That part I really liked, and they did too.

ActiVotes are handheld wireless student response systems. The ActiVotes provide polling and data collection in real-time. Beech High School purchased a set of 34 ActiVotes for each floor. The principal informed the teachers that they needed to share votes with other teachers. Steven expressed some interest in using the ActiVotes in the classroom in the future, but had not used them at the time of our interviews.

Lilly was the only participant who had used the ActiVotes in her classroom at the time of the study. She used the software to make question pools for the students. She explained, "I use the votes at least once a week. The students like to use them for answering questions. After 10 or 11 questions, students become bored with them."

The ActivWand is a longer version of the pen. It is designed to allow access to the entire board to those who may not otherwise be able to reach it. Only the elementary teachers were given an ActivWand. Whitney explained the advantages of using the ActivWand,

> The students enjoy the wand. You know with first grade they still have to use the stool so they can reach the board easier. They liked that the wand allowed them to extend their reach across the board. They could not write really well with it, but they could manipulate moving things on the board easier.

All of the elementary teachers reported that they were satisfied with the wand. The elementary teachers used the wands daily and considered it a critical component to the interactive whiteboard.

**Time**

The amount of time the interactive whiteboard was used varied by participant. The time ranged from two hours per day to six hours per day. Two of the participants did not report specific amounts of time that they spent on the board. The other four, when asked how much time each day they used their interactive whiteboards reported that they either used the board constantly, most of the day without turning the board off; or periodically, only for specific activities or times of the day.

Lilly said, “I spend five hours a day on the board. In the morning, the first thing I do is turn on the board and make sure that everything is working.” The only times Lilly was not actively using her board was during her one-hour lunch when she was helping students with their homework on paper, and her one-hour planning period.

Steven also reported that he spent a substantial amount of time using the board. He stated he had an hour of planning in the morning, but he turned it on anyway. He wanted to make sure that it was all up and running so he could focus on gathering his thoughts and prepare for his classes. In total, he reported that the board was on for about six hours a day.

Sandi said she used her board a couple of hours a day. She reasoned, “I know they are expensive, and I really want to use them as much as possible. With Kindergartners…you can’t stay on one method of learning the entire time. You will lose them really fast.” So she tries to mix it up by using the board a little in the morning, some in the afternoon and a little before it is time to dismiss.

Whitney discussed how she used the interactive whiteboard in her classroom. She explained that she turned her board on as soon as she came in each morning,

> I want to make sure that it is working before I start my day. I use it a lot in my class. I have to keep things moving though…if you spend too long on a subject they won’t have enough time for the others. I also want to keep their attention, which is hard to do with first graders, so I can’t spend too long on the board. We switch around a lot from the board to their dry erase boards. Oh, I would say that I spend at least two [hours per day] on the board.

**Technology Beliefs**

All of the participants indicated that the use of technology in the classroom had a positive effect on students. The participants were sensitive to the different learning styles that students possessed, and indicated that interactive whiteboards helped to provide a method for reaching those different learning styles. The participants did not believe that the incorporation of technology made teaching easier. They agreed that it was a new device that they had to learn, and could sometimes cause problems in content delivery. Overall, the participants indicated that technology is part of a student's environment, and not having technologies that can present information in variety of ways could hinder a student success.

They expressed their beliefs that technology was needed to help make the connection to content in the classroom. They welcomed the use of the interactive whiteboards, not necessarily because it made teaching easier, but because they believed that the students needed a visual representation of information that was being presented to them. Steven explained,

> We have been taught that kids today are more visual learners. I don't really remember where I heard that, but I have seen that in my students. I have discovered that I can write the exact same bunch of stuff on the dry-erase board or I could write it on the Promethean board. Students are drawn to the Promethean board because it has electricity and is illuminated…it's the same principle that draws your eye to television or movies. The kids today…their brains…if it has flashing lights and it's digital, they think it is better and they pay more attention.

Cindy described her experience with the interactive whiteboard and Kindergartners. She explained, “I have found that Kindergartners are very touch focused.” Cindy described later that all of the activities that she used in her class have some element of touch related to the activity. She used a technique in her class that allowed a small group of students the ability to participate in skill building activities. In her classroom, she predefined centers where activities took place. Some of the centers included a writing center, technology center, and a reading center.

Cindy described her use of centers, “This was a technique that I picked up from my university courses. I didn’t have an opportunity to implement centers in my sixth grade English class. It was hard enough keeping them focused!” She continued by saying, “I was really excited when I had an opportunity to try out centers with my Kindergartners.” Cindy described her technology center,

> I really wanted to have a technology center my first year. I knew that I would have an interactive whiteboard and a few desktops in my room. I wanted to get the students used to using the computers. It’s something they will have to use the rest of their life, and I really think those skills are important. I placed my desktops next to my Promethean board so students would have an opportunity to use both computers. It was actually kind of funny. The students started to develop a habit of touching the desktop monitor instead of using the mouse and keyboard. The students tell me that the computer center is their favorite learning center.

Sandi also used her interactive whiteboard as a center in her classroom. She said, "I really want them to feel comfortable using the board and technology. They are going to be using technology the rest of their life." Sandi received an ActivWand to use with her students. Sandi described her use of the ActivWand,

> I was so excited when I received the ActivWand. The boards are mounted at a certain height in all of the rooms in Walnut Elementary. It may be a safety issue or something to do with cord length. Anyway, Kindergartners struggle with reaching the top right and top left of the screen. I bought a step stool for them to stand on so they could reach those hard to get to areas. Now that I have the wand I don't have to worry about them stepping up and down throughout class. It's been great.

Sandi used her computer center time to focus on skill building activities. She used a variety of websites and software programs to help reinforce her students' skills. Sandi bookmarked several educational websites on her browser. When the students moved to the computer center, they knew where to click and how to find the websites they were supposed to use. Sandi explained, "It's really neat watching them use the Promethean board. They know where to touch and how to interact with the websites."

Whitney believed that technology knowledge was important for a well-rounded student and to prepare for future vocations. She also incorporated center-based activities in her classroom, but did not necessarily have a technology center. When asked if daily technology use benefits students she responded,

> I think technology absolutely benefits them. They are so used to using it that it is second nature to them. I think if they didn't use it they would feel like they were missing out, or I was purposely making it harder for them. They are so excited to use the board. I have to preselect students to use the board. If not, they would all be crowed around it trying to use it.

When asked to clarify her statement about "missing out on technology use" and, "purposely making it harder for them," she explained,

> It's amazing how fast they learn to interact with technology. They know how to use the pen and arrow tool. They know how to delete annotations. They can move from one page to another, and where to find teacher notes. In the past, I have put a flipchart up for them to work on. They know where to go and how to answer the questions. I will let them work together to solve the questions. They really feel comfortable with using the board and I very rarely have to help them navigate through the flipchart.

Mallory also thought using the board helped students grasp the material. She described her use of the board, "When plotting lines and making measurements, it's faster and easier on the Promethean board." She encouraged students to come to the board and plot lines and see actual formulas in action. Mallory invited students to come into her classroom during their lunch break. She explained,

> I grab a quick bite to eat and let the students come in and work on their homework. Sometimes they are my students; sometimes they are not. They will open Pandora and listen to music while working through math problems on the Promethean

> Board or doing research for other classes. Many of my students don't have access to high speed Internet. They understand how important it is to know how to use technology and find information.

When asked why she gave up her lunchtime to allow the students to come in and use the board, she explained, "They need to work on their math skills. They love technology. Why not?" She continued, "I want to give them every opportunity I can to make them feel comfortable with math and technology. They are going to need those skills when they enter the job market."

Steven believed that having technology and not using it in the classroom was a disservice to the students. He explained, "You know…kids are moving into a world where everyone knows how to use computers. Not using technology only sets them back." To Steven, technology use was a foundation skill that should be used throughout all academic studies. Not just using interactive whiteboards in the classroom, but asking students to complete and submit assignments electronically. Steven also believed that students should implement critical thinking skills when using technology. He explained, "I have to teach them that they can not simply copy and paste information off of the net." He saw the vocational relevance and student engagement as two major reasons to incorporate technology in his classroom.

While Steven saw the importance of technology integration, he had also seen his share of bandwagon technologies come though his door. He understood that technology could help him be more efficient in delivering and distributing information, but wanted to make sure that it would last. Steven explained,

> Like I said, technology has some benefits in the classroom. I have also seen technology come and go. Have you ever heard of a LaserDisk? How about Zip disk? These were all technologies that were marketed as the next big thing. Schools spent a lot of money buying this equipment for their classrooms; money that could have been spent on hiring teachers. Plus, if you factor in electricity, training time pay, and support for these devices, it really adds up. I wonder if our school system will continue to use and support these boards after 10 years.

Steven believed that technology use in the classroom had its pro and cons. He did not mind including technology in his classroom as long as it had a lasting benefit to him and his students. He also realized that if students were not aware of certain technologies or if they lacked basic skills in technology, they would have a harder time adapting to the work environment. He explained, "You have to know how to use a computer to get along in modern life and be part of the middle class. Without those skills you are really limited in what you can do."

Lilly acknowledged that technology use came natural to her and it had always been a part of her life. Lilly was able to use personal computers when she was young. She described her family as very technical and technology driven. She explained, "I was fortunate when I was young. My parents had the money to purchase a computer. That's when computers were five or six thousand dollars." She continued, "My family loved computers and all things technical. I think technology and math go well together. I guess that is why I excel at both."

She also believed that technology is an important part of a student's development, and should be incorporated in all levels of education. When asked what type of technology resources

she provided for her students outside of the classroom, she explained, "I have told students about Wolfram Alpha, and we have used it in class. I have also shown them several math websites that they can use." Lilly acknowledged that technology was important for students to master but did not believe the argument that students today are born with an innate sense of technology use. She explained,

> I don't know where I first heard the statement that students are naturally good with technology. I don't think it is true. I have seen that in my students countless times. There are some that are really good, but most just really know how to surf the web. They know how to Google things. That's it! They act like they know a lot, but when it comes down to it they know as much as everyone else. When they come up to the board they have to learn how to use it just like the teachers did. The students have to be trained too.

While the technical skills and beliefs about technology in the classroom varied, each participant noted that it was a necessary component to a well-rounded student. The participants were grateful for the amount of technology they were given, and understood their situation was the exception, not the rule. The participants also commented that the students enjoyed the use of the board in the classroom, and were more engaged when it was in use.

**Technical Difficulties**

Each participant encountered technical difficulties when setting up and using their interactive whiteboards. The most common issues revolved around computer connectivity and software issues. The common problems help to identify answers to the research question *Do*

*teachers, at the elementary and high school level, have similar problems with interactive whiteboards and employ similar problem-solving strategies?*

**Computer Connectivity**

Connectivity with Promethean devices posed a problem for the participants. Of the participants, five reported problems with connectivity between the devices and hardware. With the purchase of the Promethean boards, the school system also purchased accessories that complemented the use of the boards in classrooms. These accessories included the ActivPen and ActivSlate. The participants referred to the ActivPen simply as the "pen." The pen allows the participant to write, left and right mouse click, and select objects in the same manner a mouse would be used on the computer screen. The ActivSlate, or simply referred to as the "slate" by participants, is a tablet-like device that allows the teacher to interact with the board from anywhere in the room. The teacher is able to use the slate and pen remotely through a wireless connection to a USB hub that is plugged into the computer.

Five out of six participants reported problems with their ActivPens. Mallory reported, "the actual pen itself is sometimes the problem…the pens do wear out. The boards last great but they do have to make an order to replace the pens." Although the ActivPen does not have ink or lead to wear down, with repeated use over time, the plastic pieces become worn and less responsive. Mallory's constant use of the board and pen accelerated the rate at which her pen wore down.

Steven recalled, "One time I lost the pen. If you don't have a pen the board is pretty much worthless." Since the interactive whiteboards are installed with two pens that are not attached,

and ordering new pens can be cost prohibitive, losing the pens would remove the participant's ability to interact with the board. Without the pens it could only be used as a display device.

The ActivPen uses a plastic piece to make contact with the board. This piece is used to align the pen movements with the cursor on the computer. The participants refer to this part of the pen as the "nib." Sandi explained, "The nib of the pen is the little thing that comes out if you are not careful. The guys from technology sent an email making sure that we stored the pens with the nib up." She explained that several of the teachers had already broken or lost their nibs. In some cases, the nibs fall out. She explained, "I have had to contact Johnny [her husband] for a new set of nibs for our school already."

Cindy said, "A lot of the time it is like the pen doesn't respond, or the board does not respond to the pen." In order for the computer and interactive whiteboard to communicate properly and orient the pen's responses in the correct locations, the board and computer must be calibrated. Often, when a computer is disconnected or powered off, the next connection will require calibration. If not calibrated, the pen could either be out of alignment with the mouse cursor on the computer screen or not respond at all.

Lilly also had problems with ActivPen. She explained, "the pen becomes balky when it doesn't work the way you want it to. One time I changed color to highlight something and it didn't want to." She continued in detail about her difficulty with the pen, including the lifespan or threshold of use and its connectivity to the interactive whiteboard:

> We have some connectivity issues with the pen and the board. That's been the most common thing this year…The biggest problems we have had lately is the pen will just

> quit working. And we have checked all of the connections and we made sure that all the USBs were in the right spot. We have restarted. We have done everything. [We ask each other,] "have you tried this?" "Yes." We have done it all; still not working.

Along with connectivity, Lilly continued about problems with the pen hardware itself:

> They have a stash of nibs that you can ask for. Then they will see if it improves the performance. It usually does. In the case of my pen, it is falling apart. It's taped together and barely holding on. It's surprising that it held on this long as much as I use it.
>
> Now we have to go and figure out the protocol on who we need to ask to get a whole new pen. We got the nibs, but now I want a whole new pen.

Overall, the connectivity and actual hardware durability of the ActivPen presented technical difficulties across all settings.

The school system purchased ActivSlates for their teachers to use in conjunction with their Promethean boards. Of the participants, two of them reported problems with the slates. Although they identified that the slate was not working, they could not determine a definite cause. For instance, Whitney reported:

> I used my slate for about a week and a half and it is having problems. Technology is going to have to look into it. I am really disappointed because I really enjoyed
>
> the slate. It allowed me to move around the room and that sort of thing. So I am disappointed that I got to enjoy that for a couple of weeks and now it's down.

Lilly observed connectivity problems with her slate every day about the same time. Although no one was completely sure of its cause, Lilly had a theory:

> There are some maintenance issues in terms of static that builds up over the day. By about fifth period you need to clean the slate off. I don't know what it is causing the interference but there is an interference at about fifth period every day. We have to clean the slate off to make it continue working properly.

The connection between the computer and projector presented some issues with screen projection. The design of the interactive whiteboard required that the projector must be mounted upside down so that the image could be displayed on the board and out of the way of the students. Because of the design, several issues emerged as the participants used the devices. Mallory reported, "The screen will flip over. Of course these projectors are mounted upside down so we use an inverted image, and occasionally we will have a problem with that." She also had trouble with the screen position:

> Occasionally, for some reason, I don't know if the projector gets off and doesn't fit the board right, it doesn't fit like it is supposed to. Sometimes we go to the projector and sometimes we go to the settings and readjust it through the monitor preferences.

There are several reasons that a projector's colors could be wrong, including projector settings and faulty cords. If a pin is bent or a cord is not completely connected, the colors displayed could be inaccurate. Cindy had an incident when her screen turned yellow: "There are a lot of little things in the hook up like that day it turned yellow on me…I guess I hit the cord and, you know, it kind of made the plug loose."

Sandi encountered two separate issues with her screen. First, she said, "I turned on my computer today and it was showing a different screen than what was on my screen over there

[her laptop]. The board was showing a different screen." Sandi was referring to a mirroring problem, when the computer and projector were not mirroring each other. When she changed the computer monitor settings, she was able to see the same screen on both the computer and the interactive whiteboard.

Then, she reported a time when the screen projected was larger than the board. This happens often when the projector restores itself to default settings. She continued:

> I couldn't figure it out and it ended up being the screen size, 1024 by 700 stretched. Well I tried that and it didn't work so they had to call somebody from technology and they had to come and fix it. But that was what was wrong. The screen was too big for the board. I couldn't figure it out. I thought I tried it, but I guess I hadn't.

All of the participants reported difficulty in synchronizing the board, projector, and computer. Cindy stated, "There was one time I couldn't get the computer to talk to the Promethean board. I knew that I had hooked them in the wrong order or something. I took everything out and then I started over."

Sandi also recognized that the computer and the Promethean board did not always communicate properly. She explained, "You know the boards are strange, and sometimes you will go in the morning and they will be all wacky and the only way to fix it is to just fiddle with it."

Mallory expressed a similar situation. She came in and went to write on the interactive whiteboard and, "I got nothing." She could tell the problem she was having was that the laptop was recognizing the board but not interactive. "Even though I could see things from the

projector, I couldn't interact with the board." When Mallory unplugged the USB cord and plugged it in again, she was able to use her pen to interact with the laptop.

**Software Issues**

Some participants experienced technical problems associated with the versions of software that were distributed with the interactive whiteboards. Boards were installed during a transitional phase between ActivStudio and ActivInspire. The version of the software participants received depended on a variety of factors. The teachers who received boards in early summer were more likely to have the older ActivStudio software. Boards that were installed just before school resumed were more likely to have the newer ActivInspire software. Midway through the semester the technology support staff installed the new version of interactive software on all of the computers. Problems arose when teachers tried to transfer their flipchart files from ActivStudio into ActivInspire.

Whitney explained the difficulty that she and her neighboring first grade teachers had when trying to convert her original ActivStudio files into ActivInspire:

> I was having problems pulling up some of my Promethean charts yesterday. We were trying to bring up some of the flipcharts from my desktop that just wouldn't come up...We tweaked it a little bit and they started coming up. She [the teacher next door] had not moved all of hers over from ActivStudio to ActivInspire but neither did I. This new computer does not have ActivStudio.

After the frustration that Whitney experienced with the different versions of the software she figured out how to import the old files. She explained, "I am able to open up one, and if it won't

open in ActivStudio, I know how to get it from ActivInspire. Because of that transition I am able to do that."

Cindy had difficulties with modifying already-made flipcharts. She accounted her experience of changing a flipchart given to her in local teacher-led training session:

> The only thing with this that I had a hard time with was it had a calendar on it. When I filled in the calendar for that month and I was ready to change it for the next month, the old stuff was still there. I never really found out how to do that, so we kind of wrote over it and made do with what we could.

Even after the transition to ActivInspire, teachers still had trouble with the software slowing down their computers. The participants discovered that the inefficiency of ActivInspire could affect the efficiency of other software. All of the participants indicated that it was difficult to run other applications in the background while using the interactive whiteboard. Lilly described the applications she ran throughout the day:

> We are running PowerTeacher to administer grades, and our email is constantly open because that is how our administration contacts us. We have iChat open because we are supposed to have that up and running. I keep Adobe Reader open to show PDFs in class. I have FireFox and Safari open with several tabs open in each browser. Usually, I have two or three Word documents that I am updating or modifying during the day, and maybe a PowerPoint.

Then she explained how that affected the performance of ActivInspire and the interactive whiteboard:

> Anytime you want to move an image, this happens when you have a PDF imported from PowerPoint, you accidently grab that image, and you have not locked it in. You move it, and it moves super slow. It's not real time. Any image that I want to drag around ActivInspire moves at an incredibly slow rate. That includes the shapes that I have created, and the ones that are created, and the pictures that I have brought in.

Mallory experienced the same situation when she had multiple applications and browsers running in the background and was connected to her board. She explained,

> Sometimes I have had this problem: if you enter too much at once you will get this little spinning disk and it is like it is overloaded; and sometimes it will take a few minutes and it will come back, and sometimes you will have to shut down your computer to get it to work again.

Mallory recognized that the number of applications running on their computers seemed to affect the speed of ActivInspire, and came to the solution that restarting the computer would resolve the problem. She commented that it was inconvenient to have to restart the computer in the middle of a class session.

All of the participants reported technical difficulties that were related to the interactive whiteboard. The difficulties included problems with peripheral devices, including the ActivPen and ActivSlate, as well as computer connectivity with the projector. A few of the participants had difficulties with the computer recognizing devices that were attached to it, and software difficulties that were related to migrations from the older version of Promethean's software to the newer version. All of the participants commented that the Promethean software was inefficient.

## Problem Solving Techniques

All of the participants encountered problems at some point in their set up and use of the interactive whiteboards. What they did to solve these problems helps to answer the research question *When encountering technological problems that prevent them from fully utilizing the features of their interactive whiteboards, what kind of troubleshooting techniques do teachers use before seeking a technician's assistance?* The four major pieces that played a role in troubleshooting problems involved the teachers' proximity to those who could help them, working with peers to find the answer (peer-sourcing), using prior knowledge about other technologies and situations, and basic trial and error techniques.

### Proximity

All of the research participants requested help from a neighboring teacher. The amount of help needed among the participants varied based on technical background and general comfort level with technology use. The participants were able to determine who was more skilled with the use of the Promethean board within their hallway and ultimately within the school.

At Beech High School, participants' classrooms were located on different floors. They would only rely on their close neighbor for assistance when troubleshooting the interactive whiteboard. Interestingly, grade level and content area did not affect the selection of a teacher for assistance. Although Steven was a social studies teacher, his room was located in same hallway as the other math teachers. On occasion, he reached out and asked a math teacher across the hall to help him. Once, the projector was not producing the normal amount of light. They worked together and discovered that a student had placed some plastic wrap on the projector lens.

Cindy also illustrated this point by saying, “I would look across the hall and see if there was a teacher that could help. If she didn’t look busy I would quickly ask for help.” Although Cindy taught kindergarten and her neighbor was a first grade teacher, she felt comfortable asking for her help. All of the participants indicated that they had made time to help each other solve problems with the board. Distance in the building was an indicator on how far the participant would reach out and ask for help. In Cindy’s case, the technology coordinator was located on the other side of the building. Cindy explained, “It was really to far for me to travel all the way over to the technology coordinator desk to ask just a quick question. Plus, you had no way of knowing if she was in her room or not.”

Whitney relied heavily on the assistance of other teachers to help her troubleshoot her technology problems. The location of Whitney’s room gave her the biggest advantage of the teachers in her school when asking for assistance. Whitney explained, “I really lucked out. I share a wall with another first grade teacher. There is a door that connects the two rooms, and if I have trouble I just peek in and ask for help.” Whitney also benefited by being two rooms away from the technology coordinator. She said, “If I hear that she [first grade teacher] is busy, I will quickly walk down to see if the coordinator is there.” Walnut Elementary had a full-time teacher’s assistant who also served as the school’s part-time technology coordinator. She was responsible for helping the teachers troubleshoot any computer or Promethean problem they encountered. If she was not able to solve the issue, she was responsible for submitting a support ticket to the technology department. A technician would come to the school and work with the technology coordinator to solve the problem.

Mallory shared hall duty with two other math teachers. Students at Beech High School only had five minutes to change classes. During this time teachers exchanged ideas about issues they were having with the board. Mallory explained,

> Our department is split between two floors, but my room is next to two other math teachers. We stand in the hall and exchange tips, or discuss problems we are having with the board or our pens. We don't have a lot of time to talk so if someone has a problem it is usually the topic of our conversation. If no one knows the answer, the head of the math department is just down the hall. I have asked him on occasion for help.

Mallory only contacted teachers who were close to her, even though there were more math teachers on the third floor with Promethean boards. If the teachers were not able to come to a solution they would discuss it with the department head. She explained, "My first day here the department head told me that if I needed anything at all just to ask him."

Sandi provided assistance to other teachers in her hall that had interactive whiteboards. She noted, "In the morning, or sometimes in the hall, a teacher would ask a quick question about the board. I would try to answer it, but if I didn't know the answer I would go and take a look at it." Sandi did not hesitate to walk down the hall to help other teachers with their problems. Sandi explained that she would only go two or three doors down to answer questions. The teachers who asked for assistance either shared a wall with her room, or they were in close proximity.

Lilly's situation was very similar to Sandi's. Lilly explained, "when we all got the boards it was great, but some people needed more help than others." Lilly described herself as the

technology contact for her floor. Lilly was designated as a mentor for the third floor math teachers by the department head. She explained,

> I guess because there are only four of us up here they needed someone to guide the teachers and help them…I have the most amount of experience teaching, so naturally that made me the best person for the job. I have always been a go-getter when it comes to technology in my classroom. If it's in here, I am going to use it and figure it out.

Lilly enjoyed that fact that she had become a technology contact for the teachers on the third floor, and took pride in helping other teachers. When asked to explain why they chose her she said, "we are up here alone, plus, I produce a competent persona…maybe that's why."

Steven took a pragmatic approach when he needed assistance with the board. The majority of the time he would just submit a help ticket and the technician would come and help him with the problem. There was a standard technical protocol in place for all high school teachers to follow if they experienced issues with the interactive whiteboard. They were instructed to log on to the school system's technology department help desk website and submit a support ticket. A technician would answer their tickets in the order they were received. He prided himself on not asking for help. He explained, "Some of the teachers here freak out over every little thing when it comes to technology." Steven believed that the teachers should be responsible for solving their own problems. He explained,

> I'm not really the best person to talk to about working with other teachers. I don't hang around after school and talk about school stuff and share teaching stories and stuff like that. The people here don't really share my same interests so I don't really talk to a lot of

people. These boards are so simple to use, a monkey could figure them out. If someone needs help I will help them, but I am not going to drop what I am doing and run across the school and help them if I am in the middle of something.

Steven was frustrated that so many teachers were not able to adapt and use the interactive whiteboards. He said, "I know only a few teachers were able to attend the training before they got their boards, but come on. It's not that hard." He also noted that teachers would often reach out too much when seeking assistance, and they should just try to figure it out on their own. He explained, "I know only a few of us have the boards, and that's fine. But sometimes I wish I could just close my door during planning and not help anyone."

**Peer-Sourcing**

All of the participants sought out a peer to find a solution to a particular problem they were having with the interactive whiteboard or accessories. Peer-sourcing was demonstrated when participants were not able to solve a problem by themselves. With the help of another teacher, the teachers would communicate their issues with other teachers within the school until a solution was discovered.

Sandi explains,

> One of the teachers stopped by my room in the morning and asked if I could come and take a look at her board. I walked down the hall and passed the technology coordinator. I asked if she would check it out too. All three of us started looking at the board and offering suggestions. We went though our normal process of checking wires and restarting. I thought the USB cable wasn't working, and the technology coordinator

> remembered that there was an update that she used to fix another teacher's USB connection.

When asked what the next step would have been if they were not able to solve the problem, Sandi responded, "At that point we would contact a few more teachers, and they would come and take a look at it." Sandi also indicated that she helped a few teachers through their school's chat system. She stated, "Every once in a while, I will get a chat message from another teacher asking for help with her board." The use of the chat system helped teachers quickly reach out and seek assistance from others who may have experienced the same issues.

Another instance of teachers participating in peer-sourcing was when Cindy was walking her students to guidance. She passed a first grade teacher in the hall that explained another teacher down the hall was having problems with the pen. Cindy explained, "After I dropped my kids off, I walked down to her room to see if I could help. I had a similar problem with my pen the week before. I showed her how to fix the problem."

Cindy benefited from peer-sourcing herself when her projector display added a yellow tint to all of the flipcharts and PDFs she displayed on the board. She explained,

> I asked the teacher across the hall if her board has done this yet [produced a yellow tint] and she responded that it hadn't. So I played with it a little more, plugging and unplugging the cables. The other first grade teacher who heard about my problem came in to help me. She knew automatically the cable had a short in it. We contacted technology and they brought me a new cable.

Whitney benefited from peer-sourcing when the ActivSlate she just received stopped working. An ActivSlate is a touch sensitive hand-held device that controls the computer, and provides the same interactive elements as an interactive whiteboard. She explained, "I used it for a day and then the next morning it stopped working." Whitney talked with the teacher she shared a wall with to see if she had any trouble with her ActivSlate. She explained, "If I run into a problem during class, I will wait until they [students] are working and I will quickly send a chat to a few fellow teachers that I will see during lunch. During our final interview, a teacher walked in and began working on her ActivSlate. She explained, "That's a second grade teacher. She is here to take a look at my ActivSlate and see if she had any ideas on fixing it. She's the third person to take a look it today."

Mallory incorporated iChat when she needed help with her board. She explained, "If I couldn't figure it out, my last resort would be to send a message to the math teachers." As the semester progressed, and more teachers were able to attend training sessions, the rate of messages teachers were receiving dwindled. Mallory relied on peer-sourcing to help solve a problem that she experienced when her interactive whiteboard projected an inverted image. She explained, "When I turned on the board, I stepped out to talk to another teacher. When I came back in, the board was messed up." Mallory asked two of the teachers that she shared hall duty with if they had a solution. She explained,

> They had no idea what had happed to my board, so I thought something major was wrong with it. The department head stopped by my classroom during my planning and asked if

he could take a look at it. He played around with the settings for about five minutes or so and fixed it.

Lilly explained her use of iChat to help others find solutions to their problems with the interactive white boards:

> At the beginning of the year, when no one had training on how to use the board, it wasn't uncommon for teachers to send blanket messages to other math teachers on the chat list. I answered a few of them, but it became overwhelming. Plus, they would pop up in the middle of the screen when I was working. I placed myself on invisible and told them to just email me.

Steven's participation in helping others troubleshoot was intentionally minimal. His resistance to answering others' questions made him equally resistant to asking questions on the school's iChat system.

> Somehow I got on this Math teacher chat list. I was getting a help message at least once a day. They [the messages] were so dumb. They were like, "how do you add a shape" or "how do you change pen colors". I ignored most of them and made myself invisible so I wouldn't get direct messages. After winter break, I started to notice that the amount of messages went from one or two a day, to one or two a week.

All of the participants incorporated some form of Internet based peer-sourcing when they were troubleshooting their problems with the board. Sandi explained, "If I couldn't figure it out by fooling with it, I would go to Promethean Planet and read the forums." The teachers were made aware of the forums when they received information about the computer-based training

modules that Promethean offered. Sandi would search the forum for topics that were related to the problem she was experiencing. She explained,

> The forums are great. You can just jump on there and search for problems that other teachers are having. They are real casual there. You can tell that these are real teachers posting questions and looking for responses. I have always read forums to answer questions about technology.

Mallory used Google to answer a lot of the questions she had about the board. She explained, "I use Google for everything. I use it to find new flipcharts and ways of using the board in the classroom. I have even used it to figure out stuff on the board."

Mallory was not alone in her use of Google as a source of gathering information. Cindy described her experience with Google, "If everyone was busy, or if it was something that I couldn't quite remember, I would just Google it."

Lilly was the only participant to post questions and respond to questions on the Promethean forum. She explained,

> If I had a question that wasn't already on the forum, I would post it. Of course I would check to make sure that it wasn't there already. Most of the technical questions were on there and easy to find. I also answered a few questions, or offered some other solutions that I knew would work.

When asked why she so willing participated in the forum discussion she explained, "Well, that's the first place I go when I have a question about the board. Why not add to the conversation?"

Whitney took a different perspective when using online resources. She said, "I would go to Promethean Planet and look through the forums. If I couldn't find the answer I would try Googling it or Yahoo." When asked if she ever responded to or answered a forum post she explained, "Oh no, I just read them. I really wouldn't know what to add. There are so many tech savvy people on the forums. I don't think I could add anything."

Enjoying the autonomy an Internet search provided, Steven used the Google for troubleshooting as well. He explained,

> This one time the board did something crazy. It was moving really slow when I moved an object on the screen. The funny thing is that it was just that object that was making it move slowly. I couldn't figure it out, and I didn't think it was worth a support ticket…I just figured it out on my own. There is so much information about these boards on the Internet; it's almost ridiculous. I searched through Google and found a forum post about it and that was all I needed to solve the problem. Someone else had the same problem and they posted a lengthy discussion on it. I just skimmed it [the forum post] and found the information that I needed.

**Prior Knowledge**

All of the participants used computers prior to receiving an interactive board. At some point in their teaching careers, they had participated in professional development sessions that focused on other technology-related applications designed for the classroom. These technologies included the use of projectors, digital document cameras, and DVD players. The amount of time

each participant had with these technologies as well as their comfort level with the technologies varied.

The participants' technology background determined their ability to acquire skills and troubleshoot problems with their interactive whiteboards. Lilly believed her personality and prior computer knowledge made her a clear choice for support when the teachers on the third floor needed technical assistance. In one case, Lilly was able to draw upon knowledge that she gained from software she had used in her past. She explained, "I was in ActivInspire, and I was setting up the clickers when I suddenly realized that they were using old code from another program." When asked to elaborate she explained,

> We used to use this program called Plato to organize student records at my old school. The software was ancient even back then. It was so old we had to have computers that had [Apple] OS 9 on them to run the software. Anyway, all of the teachers had to place their students' names, attendance, and grades, you know common things that we keep up with…setting up the clickers was a breeze. Once I recognized the software, I was able to quickly add the students and other information to the correct columns and rows. I showed all of the teachers on our hall how to set the clickers up, too.

Sandi's background and interest in technology aided her in helping other teachers solve their interactive whiteboard issues. She explained, "Teachers would often come to me a few times a day asking for help with their boards. They would usually catch me in the hall when I was taking my kids to lunch or when I was at lunch. I didn't mind helping them out." Teachers would also send help requests through chat messages. Sandi continued, "In the beginning when

we got the boards, I would get a couple messages a day. As the semester has progressed I have received fewer messages."

Sandi knew about the interactive whiteboards before the school system decided to implement them. She explained,

> I remember when I first heard about the interactive whiteboards. An interactive whiteboard manufacturer provided a presentation for the superintendent and curriculum supervisor. My husband wasn't the IT director at the time, but had a lot of say in what would be purchased. He invited me to come and watch the presentation. The program reminded me of a few drawing programs I used to use in my class. We had to stop using the software because we moved to [Apple] OS 10, and the newer computers would not support it. Those older programs really helped me in working with this new software. In some cases, the icons were even the same.

Sandi's experience with the past drawing and shape manipulation programs helped her understand the interface of ActivInspire.

Sandi also used her prior experience with technology to help solve issues she faced when using the interactive whiteboard. She reported that her computer would "beach ball" on her, making it difficult to use the software during class. "Beach ball" is the term used when describing the spinning pinwheel icon that Apple uses when the operating system is busy. Sandi remembered that she experienced a similar issue on her home computer when she used Firefox. She recalled that the version of the browser was notorious for having a memory leak, and she

experienced that same situation on her Apple at home. To solve the issues she updated her browser at school, and it solved her problem.

> Mallory volunteered to help other teachers that were having difficulties with their boards. She believed her background in advanced mechanical engineering applications would help her solve technical problems with the interactive whiteboard software. In her previous career, she used engineering programs like Maple and AutoCAD to develop sketches and plans. She considered the interactive whiteboard software to be less sophisticated than the other software programs she had used in the past. She did not indicate in the interviews or through observations that she thought her technology skills were superior to her peers, but felt more comfortable in using the software.

Mallory used her past experience with computers to guide her in diagnosing problems she encountered. She explained, "In the middle of class, the screen froze. I walked over to the laptop and tried to move the mouse cursor, and it was frozen too. So I unplugged everything." When asked why she unplugged everything instead of trying to find the application that was frozen she explained, "That's what I had to do at my old job. The computer would lock up and we had to restart every time." Mallory reverted to the process she was most familiar with from her prior experiences with similar technology problems.

Steven described his skills with technology as average or adequate. He was comfortable with the format of the ActivInspire software because of its similarity to Microsoft PowerPoint. He found many of the functions to be the same. He used PowerPoint on a daily basis, so transitioning to the use of the interactive whiteboard software was relatively easy. Because of

the lack of interactivity PowerPoint provides, Steven did have difficulty utilizing the interactivity of ActivInspire. He seemed to gravitate back to the same functions and uses he had used in the past, primarily using the interactive whiteboard as a static display device.

Steven was able to use his past experience working with projectors to help solve a problem a fellow teacher was having. During the summer, Steven works at a summer camp that focuses on agriculture awareness for middle and high school students. He is in charge of setting up the projectors for educational movies and entertainment. The teacher next door to Steven was having an issue getting the computer to recognize the projector. He quickly solved the problem by selecting a setting in the preferences. He explained,

> There are a few projectors that don't work well with Apple computers; or they just don't work well at all. I don't know. Anyway, I went over to help her and remembered I had the same issues with that type of projector in the summer. I just went in and changed some settings. It really wasn't a big deal. The teacher thought I was some kind of hero. (Laugh)

Cindy's technology experience was limited to computer use, but it made her more comfortable to allow her students to access and share the interactive whiteboard. She knew that the children would not break the computers, and allowed them to explore the features of the software with her. Cindy encouraged her students to learn with her as she tried new tools in ActivInspire.

Whitney had the least amount of experience with other technologies, and considered herself to behind in her technical skills compared to other teachers in her school. She was the

least comfortable about allowing her students to touch and interact with the board in fear that they would break it. Whitney was usually quick to seek help, not trusting herself to diagnose problems or solve them on her own.

**Trial and Error**

All of the participants used trial and error in attempting to solve the technical difficulties they experienced with the interactive whiteboards. They used a variety of techniques to solve their issues. For example, if the board would not respond to touch, Whitney would reload the webpage or she would close the program and open it again. If that did not solve the issue, she would reach out to a neighboring teacher, or send out a chat help request. In some instances, she would ask the principal to come and help her solve the problem.

Cindy reported that often the problems she encountered were related to connectivity between the board and computer. She noted that she would unplug and plug in the USB cable a few times before trying another solution. Her next approach was to unplug all of the cables and start over to see if that would work. The unplugging and plugging seemed to solve most of Cindy's connectivity issues.

If there were a problem with display, Steven would check the monitor and display settings on the computer before unplugging the cords. He explained, "Sometimes the projector is confused and resets itself to its default settings. The projector will display an image much larger than the board." Although some would see this as a connection issue, Steven viewed it as a settings problem. If changing the display settings on the computer did not work, Steven would check the projector's settings. Most display issues were solved with his two-step approach.

Sandi had issues with the projector image being too large and also dealt with an inverted screen projection. Rather than go to the cords or display settings, Sandi would check the screen resolution on her computer. This would often solve the problem of the image being too large, but would not fix the inversion. She had to "play around" and "fiddle with it" a little more to discover the settings in the projector were reverted to the factory settings. Since the projector was mounted upside down, Sandi had to change the settings to flip the display image.

Sandi was the least likely to seek assistance from others. She explained, "If I had a problem, I would just work on it until I figured it out." When asked how often she reached out for assistance, she commented,

> I really tried not to. Every once in a while I would talk to another teacher…the teachers here are so busy and most of the time I was able to figure it out on my own. Usually it was an error that I was making, not the board.

Mallory would also try to unplug cords, check display settings and projector settings, and restart ActivInspire. If they did not work, she would restart the computer as a last resort. If the interactive whiteboard was lagging or could not keep up with the commands she gave the board, she did not think the cords or settings would help. In this case, she would go straight to restarting the computer to improve efficiency.

Lilly had issues with interference between her ActivSlate and its pen. She progressed through a succession of troubleshooting steps including unplugging and plugging cords, restarting ActivInspire, restarting the projector, and restarting the computer. When none of these approaches helped, she tried cleaning the ActivSlate with an anti-static monitor cleaner. This

seemed to reduce static, which in turn reduced the amount of interference between the slate and the pen. Lilly's perseverance led her to find a solution to a problem that none of her colleagues could solve.

**Summary**

The participants' experience with the interactive whiteboards provided data to answer the study's research questions. Without prior experience in using interactive whiteboards, teachers attended and appreciated different types of training, used various problem solving strategies, and addressed both hardware and software technical difficulties in order to utilize their boards for a variety of purposes. Chapter Five examines the findings from this utilization study and makes connections across participants to further inform the research questions through discussion and interpretation of the findings. Chapter Five also includes conclusions and implications for educators, administrators, and trainers, in the form of a proposed training model.

# Chapter 5

## Implications, Recommendations, and Conclusions

This study utilized a case study approach to answer the research questions. The questions that guided the research study were:

1. *How do K-12 teachers without prior experience in using interactive whiteboards begin using and integrating interactive whiteboards in their teaching practices?*
2. *What type of technology training do teachers perceive as beneficial in helping them to use interactive whiteboards in their teaching practice?*
3. *When encountering technological problems that prevent them from fully utilizing the features of their interactive whiteboards, what kind of troubleshooting techniques do teachers use before seeking a technician's assistance?*
4. *Do teachers, at the elementary and high school level, have similar problems with interactive whiteboards and employ similar problem-solving strategies?*
5. *Do teachers, at the elementary and high school level, use interactive whiteboards in similar ways?*

The questions were designed to investigate the aspects of technology integration within a K-12 educational environment. The questions attempted to discern what teachers perceived as relevant training, the steps teachers took before seeking official technical support, the similarities or differences in technical limitations between elementary and high school teachers' content and pedagogy, and to determine if there are common characteristics in the way the interactive whiteboards were implemented. Together, these questions were designed to provide a greater

understanding of which theories provided relevant guidance in instructional technology integration. The information derived could help streamline the training process and better inform trainers, educators, and administrators in technology use and integration.

The conclusions are presented in the same order that the research questions were presented in the preceding chapter. The conclusions to each research question are formatted around the themes that emerged from the data. Data will be compared to the relevant research from the literature to determine if there are any parallels between the study and current literature.

**Findings and Interpretations**

The findings were analyzed for answers to the research questions, and compared to existing adult learning models and technology integration models. The primary goal of this study was to better understand the process of technology integration and adoption in the K-12 environment by answering the primary research question *How do K-12 teachers without prior experience in using interactive whiteboards begin using and integrating interactive whiteboards in their teaching practices?* and the additional research questions to help add to understanding the mechanics of each piece.

**Research Question One: How do K-12 teachers without prior experience in using interactive whiteboards begin using and integrating interactive whiteboards in their teaching practices?**

Many researchers have attested to the need for ubiquitous technology in order to use the technology as a tool to enhance curriculum and not just as a novelty (Barnett, 2003; Russell, Bebell, Cowan, & Corbelli, 2002; Silvernail & Lane, 2004). The school system had a ubiquitous

environment in their elementary schools and in the math department at the high school. Teachers were encouraged by their administrators and each other to share in the use of the newest technology they had access to: interactive whiteboards.

Each teacher decided on the type of training they believed to be most beneficial to them. This was greatly determined by the amount of previous experience they had with technology, their willingness to try new techniques with or without training, and how comfortable they felt troubleshooting their own problems. Some were able to troubleshoot independently and others relied on their peers, administrators, or technicians to solve their technical difficulties. The technical difficulties did not vary between participants in elementary and high school settings. Because the hardware of the interactive whiteboards was the same in both settings, the technical difficulties were also the same. Although the hardware was the same, the teachers used their interactive whiteboards differently according to their teaching placement, either in elementary or high school. The participants were drawn to their peers throughout the integration process through training, sharing use case stories, and troubleshooting problems with their interactive whiteboards.

**Research Question Two: What type of technology training do teachers perceive as beneficial in helping them to use interactive whiteboards in their teaching practice?**

This research question attempted to examine what teachers perceived as beneficial training. Gatlin (2004) reinforced the notion that the teacher is the determining factor in how technology will be implemented, how it will be combined with the curriculum, and the degree to which the implementation will be successful. If teachers do not believe the training was

beneficial, they will not be able to adequately implement what they learned into their classrooms or teaching practices.

Two of the research participants received a basic one-hour introduction to the interactive whiteboard through a technology integration course at the university. The university required all teacher candidates to pass the course with a letter grade of a B or higher before moving through the teacher education program. The other participants were not able to attend a training session because of the limited amount of training opportunities that were available prior to receiving their interactive whiteboards.

Participants were given an opportunity to participate in a variety of training sessions during the school year. Of the training sessions provided, the majority of participants indicated that the computer-based training was the least beneficial of the three training types. The participants indicated that the design of the training module was too rigid and was not flexible enough to meet their learning needs. This sentiment reinforced the Concerns-Based Adoption Model (CBAM) proposed by Hall and Hord (1987, as cited in Shuldman 2004) that teachers go through seven stages of technology adoption including awareness, informational, personal, management, consequence, collaboration, and refocusing. Those who did not find the informational Flash tutorial beneficial were likely beyond the informational stage of adopting their interactive whiteboards. They were looking for ways to personalize its use, manage its implementation, or see the day-to-day consequences of using the interactive whiteboard, which was not provided by the Flash tutorial. Only one of the participants commented that she actually

enjoyed the use of the Flash tutorial, indicating she was likely in the informational stage of CBAM.

The use of the cheat sheet was beneficial to the participants when they first began using their interactive whiteboards, indicating they were in the informational stage of adoption. Half of the participants indicated that they had referenced the cheat sheet more than once when using their interactive whiteboard. As the participants became more comfortable with the basic functionality of the board and they moved into higher levels of adoption, their reliance to the cheat sheet dwindled. A few of the participants went beyond the use of the Flash tutorials and cheat sheet by searching for videos and websites online that focused on using the interactive whiteboard in the classroom. Their motivation to seek additional information online reinforced Knowles's concept of andragogy (Knowles, Holton, & Swanson, 2005). The participants demonstrated that they were task-oriented and self-directed in acquiring the knowledge they needed to implement the interactive whiteboard in their classrooms.

The participants' dislike of the Flash tutorials, heavy use of the cheat sheet, and willingness to search for videos and websites for additional information is in line with what Wlodkowski (2008) stated about teachers taking a pragmatic approach in learning how to implement new technologies in their classroom. They did not want to waste time learning the basic features of the interactive whiteboard. Instead, they searched for features that they thought would benefit them the most. The heavy use of the cheat sheet at first indicates that they were seeking information in a just-in-time format to accomplish what they needed from the device.

Participants indicated that the professional-based training was beneficial even though they already had access to the interactive whiteboard. Several participants commented that the session was "vibrant" and full of information. Half of the participants commented that they had already gained the basic skills prior to attending the training session. Mallory and Whitney indicated that too much information was delivered, and wished the information was presented at a slower pace or broken into more manageable sections of information. These findings are in line with the concepts described by the TPACK framework. The participants who thought too much information was presented lacked a foundation in general technology knowledge (Harris, 2008).

Because of their extensive technology knowledge and pedagogical knowledge, Lilly and Sandi believed that the session did not present them with knowledge that they had not already gained through using the interactive whiteboard on their own. As Mishra and Koehler (2006) assert, they were able to develop content-specific examples and adapt their technological approaches independently.

Participants with a deeper technical background benefited less from the professional training, while the participants with the limited technical background benefited the most. This finding corresponds with the literature that states the more exposure a teacher has with technology outside of the classroom, the more comfortable they are when introduced to new technologies in the classroom (Wozney, Venkatesh, & Abrami, 2006; Koehler & Mishra, 2008).

Teachers who attended a colleague-based training found it beneficial for different reasons. After exploring the boards on their own and going to the professional training to discover features and the technical side of the boards, the teachers were able to move on to action

and implementation. They were given specific examples that were relevant to their teaching and had worked in another teacher's classroom. This supports Wozney, Venkatesh, and Abrami's (2006) findings that teachers who perceived that technology would help them deliver information more easily responded favorably to the technology. When the participants could see how it helped someone else like them, they were more able and willing to try it in their own classrooms.

The colleague-based training also provided a safe learning environment for Whitney. She felt more comfortable training in a small group with like-minded teachers. Whitney was able to make the connections to the content that she may not have been able to make in a large group setting. All of the participants who attended the colleague-based training responded favorably to the training session. The teachers who attended this session shared the same goal of understanding and utilizing the interactive whiteboard in the classroom. This reflects the literature findings that when teachers are working together, the learning process becomes social and part of the school culture (Putnam & Borko, 2000).

**Research Question Three: When encountering technological problems that prevent them from fully utilizing the features of their interactive whiteboards, what kind of troubleshooting techniques do teachers use before seeking a technician's assistance?**

All of the participants were in a ubiquitous interactive whiteboard environment. The teachers in the elementary school and math teachers in the high school each had interactive whiteboards and were strongly encouraged to use the boards on a daily basis. Some of the research participants had contact with teachers that were able to attend the professional training held during the summer. Interestingly, not every participant within this study sought out a

teacher that attended the summer training. This section is organized around the central themes that emerged from the data.

At the beginning of the semester, a few technical issues were apparent with the interactive whiteboards. Two of the participants had minor issues that were ultimately related to faulty video cables. There was a standard technical protocol in place for all high school teachers to follow if they experienced issues with the interactive whiteboard. They were instructed to log on to the school system's technology department help desk website, and submit a support ticket. A technician would answer their tickets in the order they were received.

The elementary school incorporated a different approach to technology assistance. Walnut Elementary had a full-time teacher's assistant who also served as the school's part-time technology coordinator. She was responsible for helping the teachers troubleshoot any computer or Promethean problem they encountered. If she was not able to solve the issue, she was responsible for submitting a support ticket to the technology department. A technician would come to the school and work with the technology coordinator to solve the problem.

The interactive whiteboards were reliable for the most part. There were a few technical issues that hindered participants' use of the boards. The main technical issue focused on the USB connection to the computer and the video connection to the projector. Elementary participants experienced this issue the most, because they were using their laptops to connect to the interactive whiteboards. Administrators resolved this issue by placing desktop computers in each room. Desktops were then permanently connected to the interactive whiteboards. Because every teacher in the building had a board, the administration was able to see a pattern of problems

emerge that would not have been as apparent if there were fewer teachers with interactive whiteboards. This reinforced the literature findings that for a technology implementation to be successful, it has to be presented in a ubiquitous environment (Barnett, 2003; Russell, Bebell, Cowan, & Corbelli, 2002; Silvernail & Lane, 2004).

When participants experienced a problem, they would reach out to their neighbor. Proximity was initially the most frequently used troubleshooting technique. Elementary participants felt the most comfortable asking anyone in the school for help. Of the elementary participants, Whitney reached out the most for assistance and even included the principal as a potential contact when seeking technical assistance. The elementary school already possessed a close-knit community of teachers. Implementation of interactive whiteboards provided them with a device that drew them in even closer. Bandura's (1977) social learning theory describes the way the elementary teachers were able to collaborate, decide what was important or not, how to troubleshoot, and develop groups of model teachers to go to in times of trouble.

The high school participants did not benefit from a close teaching community as did the elementary participants. One reason for the lack of closeness in the high school participants was the separation of the math department. The math department was located on two different floors, the first and third floors of a 400,000 square foot building. The participants commented that they would only see the other math teachers during faculty meetings. Another factor that restricted the high school teachers' access to one another is the confining nature of their teaching schedule. The math participants would spend all day in their rooms, while the elementary participants had the ability to move throughout the school. The elementary participants indicated that they were

able to ask other teachers questions when they were taking their students to and from recess and when they picked their students up from lunch.

All of the participants participated in peer-sourcing when faced with a technical difficulty. Similar to professional learning communities (Dufour & Eaker, 1998), the participants banned together to help solve their technology issues. Because the participants shared the same goal, learning how to use the interactive whiteboards, they were compelled to help one another. The high school participants relied more on their chat application to gather information from other teachers. This was a result of the department being split between two different floors as well as the confined nature high school course structure. These results reinforce the importance of professional learning communities when implementing new instructional technologies in the classroom (Dufour, Durfour, & Eaker, 2008).

While participants demonstrated the tendency to work together to solve their immediate issues, they also sought online assistance from forums and websites. Participants who had more experience using different types of technology, indicated that they used the Promethean forums more for technical assistance than the participants with limited technical experience. The participants also used a variety of other resources to gather information for the interactive whiteboard. Only one of the participants indicated that she contributed to forum discussion, and helped to solve problems online. The majority of the participants preferred to only view the information online, and chose not to participate in the forum discussion. Seeking additional information online reinforced Knowles's concept of andragogy (Knowles, Holton, & Swanson,

2005). They once again demonstrated that they were task-oriented and self-directed in acquiring the knowledge they needed to solve problems with their interactive whiteboards.

The most prevalent technique used to solve issues was trial and error. These techniques were used first when a participant experienced a problem. The steps that the participants took to solve the problems could be refined to: check the connections to the computer, check the connection to the projector, unplug and plug back in, turn the projector off and on, restart the computer. All of the participants referenced this series of steps, but not always in the same order. In many cases, the participants indicated that these steps would solve the problem.

Interestingly, the participants who were more technically inclined would follow the steps precisely before contacting someone else for technical assistance. The participants that were less technically inclined would skip around in the troubleshooting techniques, and would ask for assistance before finishing the series of steps. For example, Whitney would try just a few steps before reaching out for assistance, even though she described the same troubleshooting steps that everyone else used. This indicates that teachers with less technology knowledge are more likely to ask for assistance even though they know the same process as teachers with more technology knowledge. This reinforces the importance of technology knowledge, and its relation to implementing instructional technologies in the classroom (Harris, Mishra, & Koehler, 2009).

The majority of participants had already identified a technology contact within their school that they would call upon if they were having issues and could not solve the problem on their own. This finding reflects the literature that states that teachers work within a community, and seek guidance and support from each other (Dufour, Dufour, & Eaker, 1998; Penuel, 2006;

Windschitl & Sahl, 2005; Stevenson, 2004; Triggs & John, 2004; Wilson & Berne, 1999).

**Research Question Four: Do teachers, at the elementary and high school level, have similar problems with interactive whiteboards and employ similar problem-solving strategies?**

A variety of technical malfunctions appeared at the beginning of the study. These malfunctions were both hardware and software related. Although all six participants had technical difficulties, the issues could not be connected with the grade level or content area. The types of difficulties varied between the devices and the participants. The participants experienced the same frequency of technical difficulties indicating that the issues stemmed from the devices, and not necessarily the participants' lack of technology knowledge.

Of the peripherals, the ActivPen was the single point of weakness for the research participants. Five out of six participants reported problems with their ActivPens. In some cases, the nib of the pen was lost or broken within the first few weeks of using the board. The participants indicated that the technology support staff responded quickly by purchasing new nibs for the pens that were reported broken. The technology support staff also sent an email to all of the interactive whiteboard participants that discussed proper handling and storage of the pens.

The ActivSlate also presented technical difficulties for both elementary and high school participants. Lilly found that the slate would become unresponsive after five hours of continuous use. In her attempt to find a solution, she used static wipes on the surface of the slate because she thought that the slate was building up static electricity. She commented that the use of a static wipe resolved the problem. Of the participants, she used the ActivSlate the most because it allowed her to navigate her classroom rather than stand in the front the entire class period.

Whitney's ActivSlate only worked for a short time and then was unresponsive. The high school participants incorporated the use of the slates more in their classroom teaching than the elementary participants. The increased use of the slates allowed them to stumble upon technical difficulties and inconsistency with the device and software that were not necessarily discovered by the elementary participants.

Participants also indicated they would lose connectivity to their computer or the projector would default to its factory settings. These settings either made the projected image too large or too small for the interactive whiteboard. Participants would have to readjust the image so that it would fit on the board's touch service.

The elementary teachers suffered technical issues with software inconsistencies. The technical support staff failed to install the newest version of the interactive whiteboard software on all of the elementary participants' laptops. This led to compatibly issues when teachers were exchanging flipcharts with one another. This issue was resolved early in the semester and only resulted in the loss of a few teacher-made flipcharts. The high school participants did not experience software inconsistencies. Since only the math department received interactive whiteboards, only one technician was needed to install the boards and the current software.

Although all of the participants experienced technical difficulties, it did not hinder their resolve to incorporate the interactive whiteboard and peripherals in their classrooms. The participants used the interactive whiteboards and peripherals throughout the study, and did not resort to traditional methods of content delivery. This finding is contrary to the literature review. The literature states that when teachers are faced with technical dilemmas, they are more likely

to stop using the technology and rely on traditional methods of content delivery (Bauer & Kenton, 2005; Cuban, Kirkpatrick, & Peck, 2001; Silvernail & Lane, 2004).

**Research Question Five: Do teachers, at the elementary and high school level, use interactive whiteboards in similar ways?**

All participants received the same devices at the same time. Initially, their use of the devices was the same. They generally used them as projection devices that replaced the functionality of traditional dry erase board, TV cart, or overhead projector. Because of their lack of formal training, and unfamiliarity with the software, they were not able to take advantage of all of the possibilities that were available to them at the beginning of the semester. Within two months, the participants began incorporating features that helped them enhance their delivery of content.

When looking at CBAM (Hall and Hord, 1987, as cited in Shuldman 2004), the teachers began in the awareness stage, only using the board as they were able to use an overhead projector. As time went on, they were able to move to the information, personal, and management stages, allowing them to personalize and manage the use as was appropriate for their own classrooms. Once able to integrate other capabilities into their daily teaching, the elementary participants received additional hardware that was used to help smaller students reach the upper areas of the interactive whiteboard.

A commonality displayed between the elementary participants and high school participants was the use of content related websites. The elementary and high school teachers used the interactive whiteboards to display web-based content for their students. The websites varied from

Flash-based websites that focused on basic vocabulary skill building exercises found on PBS kids, to historical maps and images from the History Channel. The participants used the interactive board as a display device initially. With in a few weeks, Lilly and Sandi began inviting students to come up and interact with the board in front of class. At the end of the study, all of the participants invited students to come up and interact with the boards. The amount and level of interaction varied among the participants. As the TPACK framework predicts, when the teachers' technology knowledge increased, they felt more comfortable allowing students to interact without "messing up" the board (Harris, J., Mishra, P., & Koehler, M., 2009).

The elementary participants allowed their students to explore and navigate websites and teacher made flipcharts on their own with little or no guidance from the teacher during class time. The high school participants only allowed their students to interact with the board through flipcharts during class time, and only one student at a time was allowed to use the interactive whiteboard. This finding reinforces the notion by Becker and Ravitz (1999) that elementary teachers are more likely to implement constructivist based teaching practices than secondary teachers when implementing technology in the classroom environment.

While both the elementary participants and high school participants were aware of the ActivInspire software tools, the high school participants incorporated the use of the software more in their daily curriculum. The math participants started using the virtual ruler, compass, and protractor within a few weeks of using the board. The elementary participants did not include any additional tools in their use of the board. They only incorporated the use of downloaded flipcharts that were made available to them from the Promethean website or flipcharts that they

received from local training sessions. Of the participants, Sandi was the only one to explore the options completely and incorporate advanced tools and techniques into her flipcharts.

The participants had a variety of accessories that complemented the interactive whiteboard in the classroom. Of the participants, the high school teachers incorporated the slate devices more than the elementary participants. Lilly used her slate immediately, while others waited till they full understood how the board worked, or viewed how other teachers were using the slates in the classroom. Lilly's immediate use could be associated with her inability to move throughout her classroom effectively. The slate gave her an opportunity to fill a need, which enticed her to implement the slate faster than anyone else. This finding reflects Bruner's (1966, as cited in Knowles, Holton, & Swanson 2005) theory that adult learners are intrinsically motivated to learn techniques or implement new technologies if the outcome is to improve their career.

Sandi implemented a wait-and-see attitude when she received her slate. She commented that she had not decided how she wanted to implement the slate in her classroom. She focused on using the interactive whiteboard and exploring all of the activities that were available to her. At this point in Sandi's adoption of the technology, she had reached the final stage of CBAM called refocusing (Hall and Hord, 1987, as cited by Shuldman 2004). She was completely comfortable with the use of the board and its peripherals, and was looking for the next way to use the board and new slate appropriately for her classroom.

The high school participants were the only participants to use the ActiVotes. Lilly used the votes the most even though she expressed a dissatisfaction with the amount of time needed to properly activate and incorporate the votes into her classroom.

The most substantial difference between the participants was the amount of time they used the interactive whiteboard and peripherals. High school participants used interactive whiteboards and peripherals the most. In many cases, the interactive whiteboard would be on all day and used for content delivery in five classes. Lilly and Mallory used the ActivSlate more than any other participants. They indicated the slate gave them mobility needed to move throughout the classroom. Lilly indicated she would rather use the slate and not use the board. She explained the slate would give her freedom to project the computer image on any surface she chose. She also indicated it was a more efficient use of time to simply hand the slate to a student, instead of them taking time to go up to the front of the classroom and work out the problem on the board.

The participants began using the technology immediately and did not follow a linear path to technology integration as predicted by the CBAM model. Since the participants were in a ubiquitous interactive whiteboard environment, they progressed past the early stage of awareness in the CBAM model. In many cases, the participants would skip stages or arrive out of order. For example, some participants seemed to jump to the collaboration stage where they would share ideas and tips for using the interactive whiteboard in the classroom.

## Implications and Recommendations

This study has revealed that teachers are usually dependent on other teachers as they are integrating new technologies regardless of their technology background. Teachers are self-motivated to find answers applicable to them and their needs for the time being. Findings also show that different levels of training are required by different individuals, depending on their present levels of content knowledge, pedagogical knowledge, and technology knowledge. These generalizations of the study fit with the ideas of the Concerns-Based Adoption Model, andragogy, and Technological Pedagogical Content Knowledge framework.

The researcher recommends a two-fold approach to continue integrating new technologies effectively. First, a training model is needed that fits the needs of teachers with a variety of technology experience, pedagogical knowledge, and content knowledge. A training model that is derived from the data of this study is suggested to help transition new technologies into schools. The second recommendation involves future research into other ways to transition new technologies into schools and help teachers become comfortable and effective in their utilization.

## A Proposed Model for Teacher Training

From this study, the researcher is exploring best practices and usability of a training model for teachers when implementing new technology. Although this study was focused on interactive whiteboards, the same model could possibly be beneficial in other areas of technology integration in education. Assuming that many systems will have similar problems with the volume of training required versus the limited time and resources to provide that training, a

model would have to be designed to provide training without the traditional cost-prohibitive and time-consuming methods of professional or computer-based training.

The researcher proposes that when engaging teachers in a technology training environment, trainers should follow the E.L.I.T.E. plan for teacher training created by the researcher. E.L.I.T.E. stands for Enlisting Leaders in Instructional Technology Education. Since teachers demand just-in-time training, technology trainers should enlist instructional technology leaders within each school. Two teachers from each school or department with advanced technology content knowledge should attend the professional training. This training would be more advanced under the assumption that the teachers representing each school or department have extensive technology content knowledge. The trainers should spend less time on mechanics and simple interfacing, and focus more on specifics to the new technology.

Once the overview has been provided for the pair of advanced users who are now a technology leader team in their buildings, the trainer should provide them with software and materials that they can use to further their own training in appropriate uses for their classrooms and content. The trainer then should develop a support scaffold. A support scaffold is comprised of pairs of teachers who have volunteered to participate from a variety of disciplines within the school. This second level of pedagogy leader must have advanced pedagogical content knowledge and at least some degree of technology content knowledge. The technology leader team should train the pedagogy leader teams in the mechanics so that they can collaborate together on the best pedagogical implementations.

The final step in the E.L.I.T.E training process is for the technology team and pedagogy teams to model, train, and coach the rest of the users in the building with appropriate methods and applications for what they will need in their classrooms. The intent is to have a ripple effect in disseminating information and application. A model for the flow of training can be found in Appendix J.

In school, colleague-based training eliminates training to a whole group, who almost never have the same needs. Teachers are looking for hands-on, just in time, real-world experience and training. With this practical approach to training, teachers can feel more at ease with their technology and in turn are likely to use it more appropriately and more often.

**Recommendations for Future Research**

The findings of this study indicate that more research needs to be conducted to understand the processes teachers take when implementing and utilizing new technologies in their classrooms. This study focused on teachers' integration of interactive whiteboards within the first school year of implementation. Researchers could gain more insight into long-term affects and ease of use and utilization by creating similar situations for longer periods of time. A longer time period could address if teachers encounter the same problems and troubleshoot in the same ways as they might in the first year of implementation. Many school systems will not have the advantage of supplying large quantities of the same technologies to their teachers. Teachers' reactions and paths to utilization should be investigated in situations when the technology implemented is not ubiquitous, leaving the teachers without the resources of training and peers.

Research into a second-generation implementation should also be conducted. When a school system integrates a new technology across the system, teachers build technology support networks. When a second new technology is integrated, an investigation into whether teachers fall back on the same networks or create new networks would be beneficial for training on the new technology. Future research could examine how to best identify technology leaders within a school building, including but not limited to how personality, experience, skills, and interests play into the identification of an effective technology leader.

**Conclusion**

This study was designed to determine how K-12 teachers without prior experience in using interactive whiteboards make the transition to utilization in their classrooms. The case study was guided by the case study structure created by Lincoln and Guba (1985) that starts with the overall problem (how teachers begin integrating interactive whiteboards in their classrooms), the context (interactive whiteboards in the classroom), the issues (technical difficulties), and lesson learned (development of tacit knowledge). The findings from this study could be used to enhance the implementation of instructional technology integration in a K-12 environment. The depth of the study was limited to the number of participants that volunteered to participate in the study. Many of the teachers felt overwhelmed with the addition of the interactive whiteboard and expressed that participating in a research study would only hinder their teaching performance. The study produced data that could benefit professional development training and recommendations for training formats and methodologies.

The participants' experiences and reactions to the interactive whiteboard implementation were closely related to the concepts of andragogy. The assumptions made by Knowles, Holton, and Swanson (2005) as well as Wlodkowski (2008) aligned with the findings of this study indicating the importance of adult education and its relationship to teacher training. The participants demonstrated the concept of self-motivation by implementing the interactive whiteboards into their daily curricula without experiencing an initial professional development training. The participants also explored training options, which demonstrates their ability to plan and evaluate their own instruction, and decide what is relevant to their needs. They drew upon their previous experiences with technology to help troubleshoot software and solve technical problems that they encountered throughout the school year.

Although this study focused on interactive whiteboards, these findings should be considered when implementing any new technology. Teachers will build support networks regardless of the technology being introduced. These findings suggest that when implementing a new technology, the support needed goes well beyond the initial training. School systems, administrators, and trainers should account for peer relationships and training that will take place to enhance the utilization and effectiveness of the new technology.

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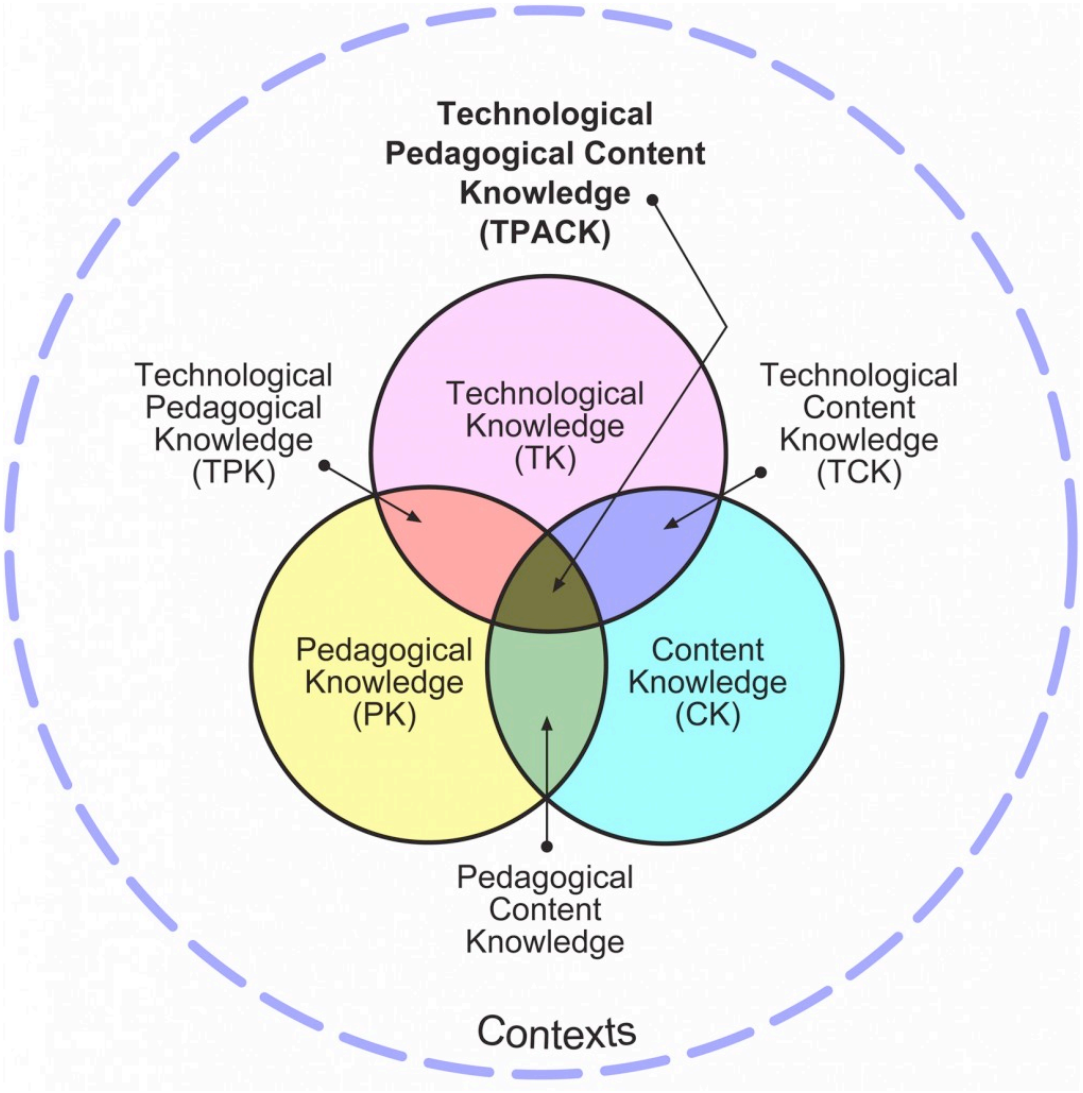
# Appendices

## Appendix A: TPACK framework

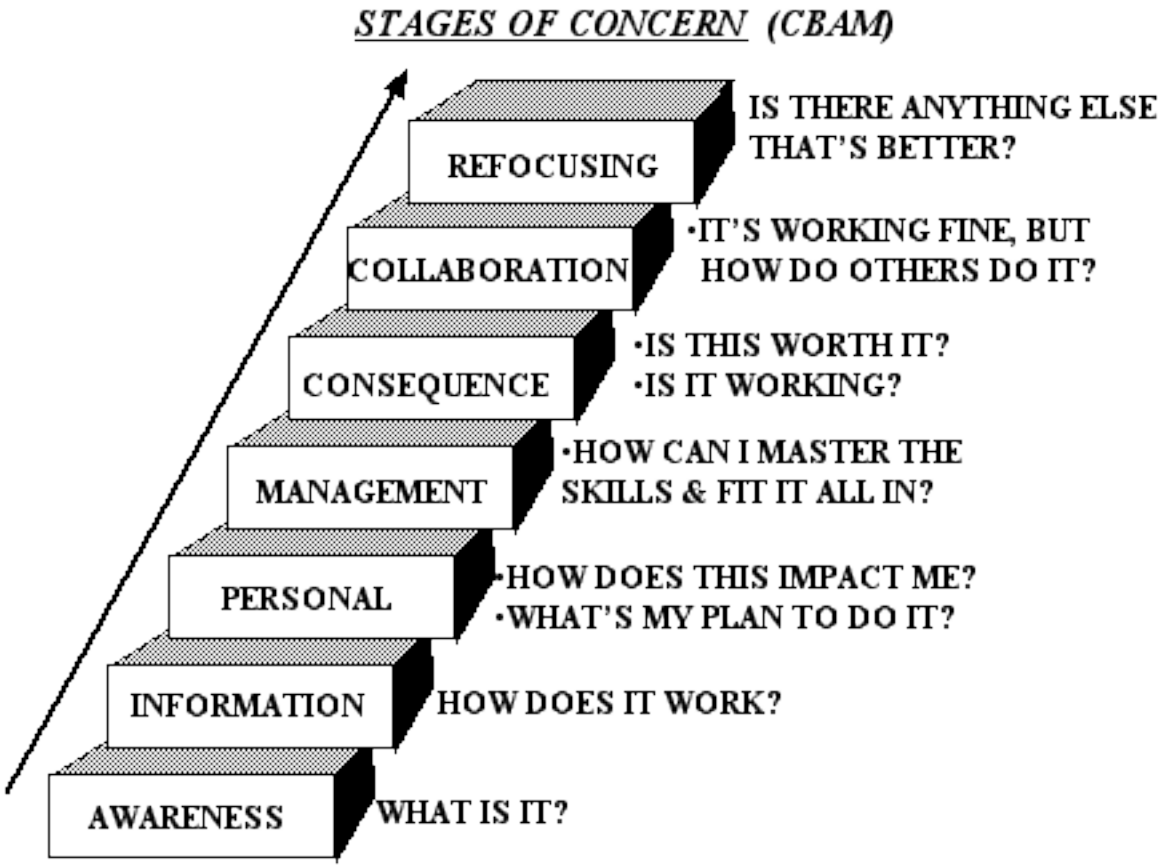
### Technological Pedagogical Content Knowledge (TPACK) Framework




This image can be found at http://tpack.org

**Appendix B: CBAM diagram**

**Concerns Based Adoption Model**




This image can be found at http://www.teachermentors.com

**Appendix C: Informed Consent Statement**

**Informed Consent Statement**

**Study: Interactive Whiteboard Integration**

[redacted] invites you to participate in research that will help promote advances in the field of educational technology. The Department of Curriculum and Instruction at [redacted] promotes the practice of protecting human subjects participating in research. Below you will find information about the proposed study. Use this information to determine if you would like to participate in the research. If you choose not to participate in the study, return the unsigned document to the researcher. If you choose to participate in the research study, you have the right to withdraw from the project at anytime. You will not be penalized, and your relationship with [redacted] will not be affected.

The purpose of this study is to determine how teachers begin using and integrating interactive whiteboards in their teaching practices. Since a large number of interactive whiteboards have been placed in [redacted] , research needs to be conducted to determine best practices in interactive whiteboard implementation. This study will observe and interview teachers in the field to determine how they integrate the interactive whiteboard into their daily routine, techniques for implementation, and troubleshooting techniques.

The researcher will meet with the participants prior to entering the classroom to discuss the details of the study. The researcher will discuss with the participant the best time to enter the classroom and observe the participant's use of the interactive whiteboard. The focus of this study is the teacher's use of the interactive white board, therefore the students will not be observed. The researcher will write notes and later interviews will be conducted about the use of the interactive whiteboard. This interview will contain no more than ten questions and the conversation will be audio recorded so the researcher can have an accurate record of the interview. The audio recording will be encrypted and stored on the researcher's laptop.

The researcher will conduct non-participator observations for two one-hour sessions at the beginning and end of the study. The participants will be given a USB drive to record journal

notes about the use of the interactive whiteboards on a daily basis. The researcher's goal is to have no impact on classroom activities. No risks are anticipated for the participants. The benefit of this research will help streamline the training process for teachers in the [redacted] County School System. Information gathered from this project will be used in workshops and will be incorporated into training techniques that will directly affect teachers who have received an interactive whiteboard. Your participation is vital to the success of this project. Your name and school will not be associated with any publication or presentation from the research collected. The researcher will assign both the participants and schools with pseudonyms determined by the participant. Identifiable information will not be shared unless required by law or you give written permission.

Participants will NOT receive financial compensation for participating in the research study. Participants will receive one-on-one training with the researcher as well as a variety of resources that can be used to help promote the use of interactive whiteboards in their classrooms after the study has been completed. You are not required to sign this consent form and you may refuse to do so without affecting any services you are receiving from [redacted]. It is important to note that if you refuse to sign, you cannot participate in this study.

If you have questions at any time about the study or the procedures, you may contact the researcher, Jason Beach, at [redacted] or P.O. Box [redacted]. If you have additional questions about your rights as a research participant, you may call [redacted] or fax information to [redacted], write to [redacted] Office of Research at P.O. Box [redacted], or email the Office of Research at [redacted]

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**CONSENT**

I have read this consent form and have had an opportunity to ask and receive answers to any questions I have regarding the study. I agree to take part in this study as a research participant. By my signature I affirm that I am at least 18 years old and that I have received a copy of this consent form.

_____ _____

Participant's Signature Date

_____ _____

Investigator's Signature Date

## Appendix D: First Interview Protocol

**First Interview Protocol:**

**Topic Domain: Classroom ActivInspire Integration**

*Leadoff Questions: You seamlessly move from content area to content area. Could you walk me through the process of designing your lessons using ActivInspire?*

Possible Follow-ups:

1.) Can you describe the typical day from start to finish using the interactive whiteboard?

2.) Can you describe how you were trained using ActivInspire and the interactive whiteboard?

3.) What are some of your favorite features in ActiveInspire, and how do you use them in your lessons?

Convert Categories: [Lesson Creation, ActivInspire development, Training, Community lesson development]

**Topic Domain: Promethean Board Use**

*Leadoff Questions: Can you describe to me how your classroom teaching has changed since you received your board*?

Possible Follow-ups:

1.) Who do you turn to when you want to know more about the board?

2.) Who do you talk to when you board doesn't respond?

3.) Tell me about how you troubleshoot problems with your board.

Convert Categories: [Problem networking, Technology support structures, Troubleshooting, Community Networking]

## Appendix E: Second Interview Protocol

**Second Interview Protocol:**

**Topic Domain: Technology Use**

*Leadoff Question: The semester is almost over. Could you tell me about your experience with the board since the last time we spoke?*

Possible Follow-ups:

1.) Could you tell me about any new techniques that you have learned since we last spoke?

2.) Have you had an opportunity to help someone with their board? If so, could you tell me about that?

**Topic Domain: Support**

*Leadoff Question: Since the last time we spoke, have you had any problems with your board?*

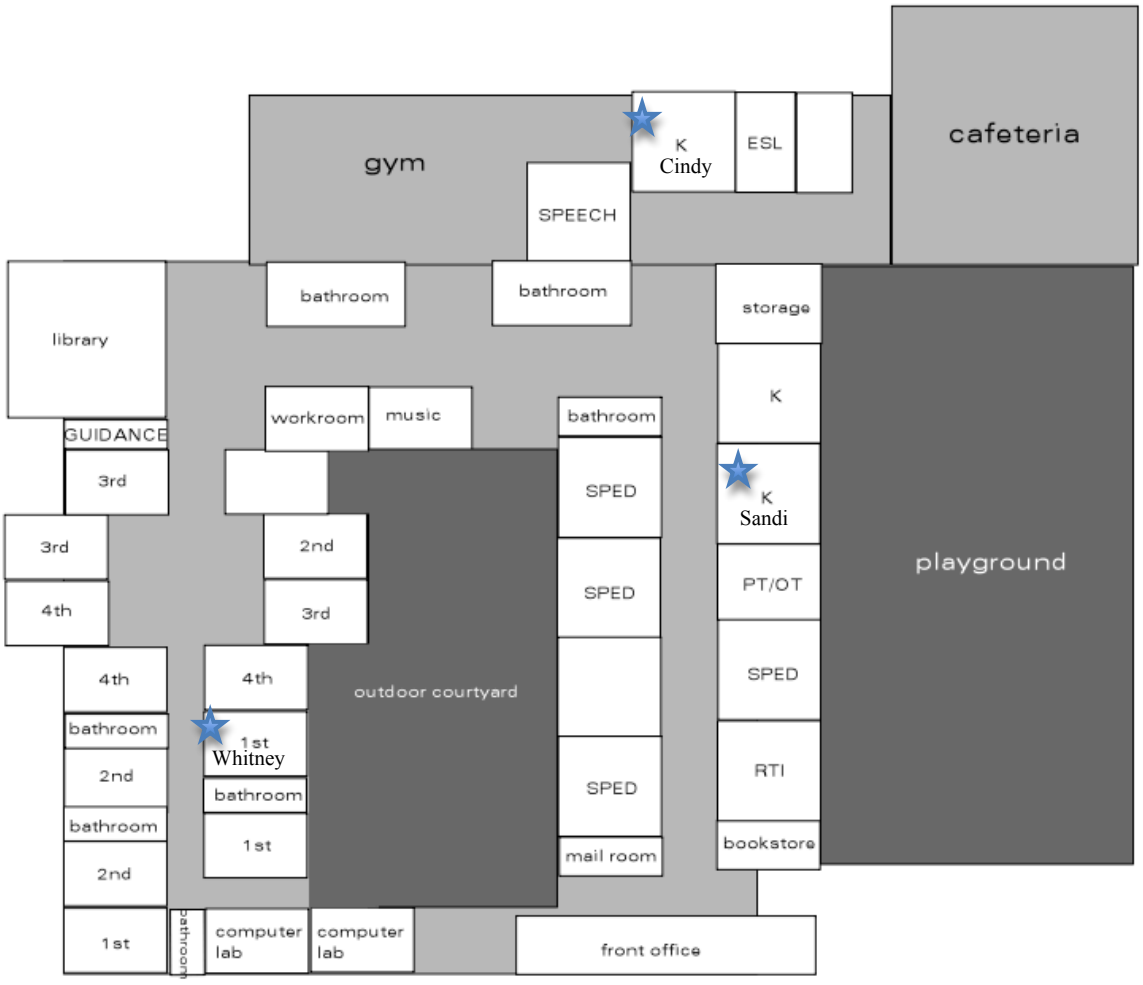
Possible Follow-ups:

1.) You mentioned Ms. _____ last time we spoke. Do you still contact her first if you have any questions?

2.) Have you had an opportunity to explore any training sessions? Do you plan to do so during the summer?

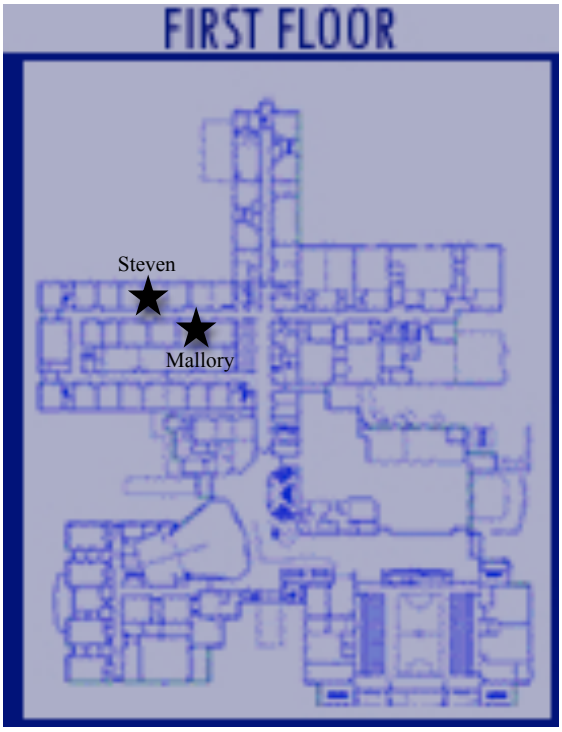
## Appendix F: Layout of Walnut Elementary School

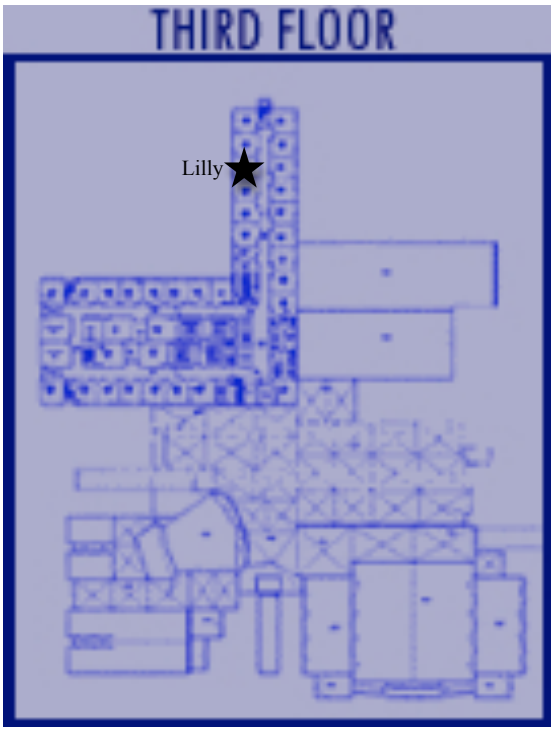
## Layout of Walnut Elementary School



## Appendix G: Layout of Beech High School

### Layout of Beech High School



## Appendix H: Journal

**Journal** **Date** _____

Please take the time to journal 3-5 times a week about your use of your interactive whiteboard.

1. How long did you use the board today?

2. For what activities did you use the board?

3. Did you encounter any problems?
    a. What happened?

    b. What did you do to fix it?

    c. Did you contact anyone else for help? If so, who?

    d. Did you get it fixed?

4. Do you have any other comments about your board or the use of it?

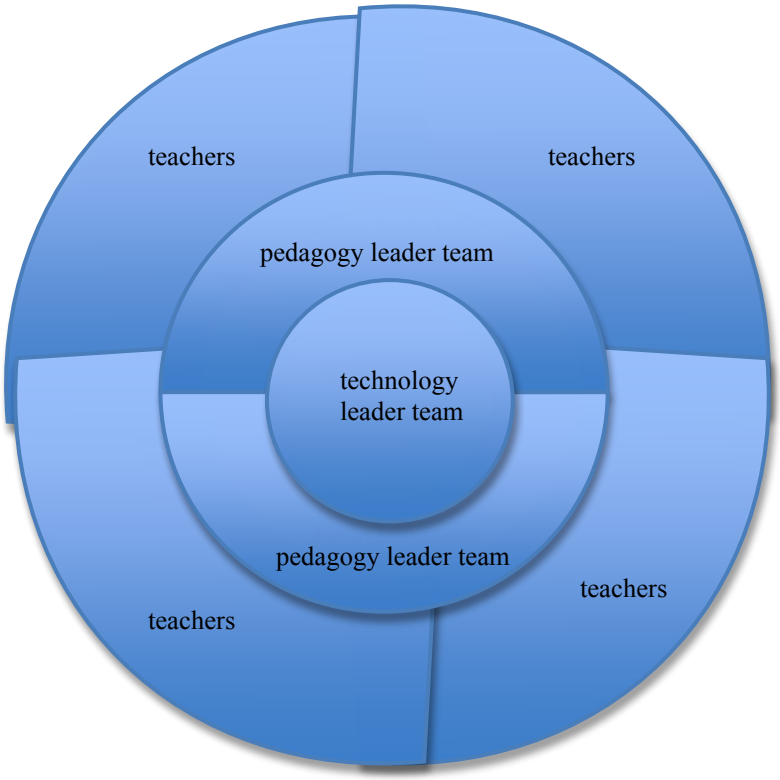
## Appendix I: Stake's "critique checklist"

## Stake's "critique checklist"

1. Is the report easy to read?
2. Does it fit together, each sentence contributing to the whole?
3. Does the report have a conceptual structure (for example, themes or issues?)
4. Are its issues developed in a serious and scholarly way?
5. Is the case adequately defined?
6. Is there a sense of story to the presentation?
7. Is the reader provided with some vicarious experience?
8. Have quotations been used effectively?
9. Are headings, figures, artifacts, appendixes, and indexes used effectively?
10. Was it edited well, then again with a last minute polish?
11. Has the writer made sound assertions, neither over- nor under-interpreting?
12. Has adequate attention being paid to various contexts?
13. Were sufficient raw data presented?
14. Were the data resources well chosen and in sufficient number?
15. Do observations and interpretations appear to have been triangulated?
16. Are the role and point of view of the researcher nicely apparent?
17. Is the nature of the intended audience apparent?
18. Is empathy shown for all sides?
19. Are personal intentions examined?
20. Does it appear that individuals were put at risk?

## Appendix J: E.L.I.T.E Training Model

### Enlisting Leaders in Instructional Technology Education



# VITA

Jason Scott Beach was born on January 30, 1979 and lived in St. Petersburg, Florida until his family moved to Scott County, Tennessee when he was in 4th grade. In May of 1998, Jason graduated from Scott High School and enrolled at Roane State Community College. Jason left Roane State Community College in 2000 and enrolled at Tennessee Tech University where he pursued a degree in Secondary Education with a focus in History, Geography, and Computer Science.

After completing his undergraduate degree, he began pursuing his Master's Degree in Instructional Leadership at Tennessee Tech University. While he was completing his Master's Degree he worked closely with the department of teacher education and taught several courses that focused on technology integration. After graduation, Tennessee Tech University hired him to teach technology integration classes for the 2+2 program. In 2006, he applied for the doctoral program at The University of Tennessee, Knoxville and pursued a Ph.D. in Instructional Technology with a cognate in Adult Education.

As an Assistant Professor at Tennessee Tech University, Jason teaches courses that focus on technology integration, research and design, and technology literacy. In May of 2012, Jason was awarded the doctor of philosophy degree. Jason continues researching the use of technology in the classroom and how it can be applied to enhance content delivery. Some of his research interests include more efficient technology training models, augmented reality, interactive whiteboards, students response systems, and computer assisted instruction. Jason and his wife Natalie, who also works in the field of Education, live in Cookeville, Tennessee.