THE IMPACT OF TEACHER ATTITUDES ON TECHNOLOGY USE DURING INSTRUCTION

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The Impact of Teacher Attitudes on Technology

Use During Instruction

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ABSTRACT

Michael D. Dartt. THE IMPACT OF TEACHER ATTITUDES ON TECHNOLOGY USE DURING INSTRUCTION. (Under the direction of Dr. Amy McDaniel). School of Education, May, 2011. This collective, instrumental case study measured the impact of attitudes on the amount of time technology was used by three Algebra 2 teachers. The Theory of Planned Behavior (Ajzen, 1991) served as the theoretical framework. Data was collected through pre-observational surveys, classroom observations, and stimulated recall interviews. When common attitudes were discovered in participants, the amount of time that they used technology differed. Regarding the impact of attitudes on the amount of time spent using technology, results were mixed. In some instances attitudes had a profound influence, but in other circumstances they had none. There were cases where obstacles prevented the participants from using technology. Therefore, elements besides attitudes should be considered when determining why people neglect employing technology.

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CHAPTER ONE: INTRODUCTION

Background

On February 17, 2009, the American Recovery and Reinvestment Act (ARRA) was signed into law by United States President Barack Obama (Open Congress, 2009). This economic stimulus package was estimated to cost $787 billion from 2009 to 2019. Of this sum, $650 million was designated for educational technology to fund computer labs and develop the technological skills of teachers (Pelosi, 2009).

Appropriating money from the ARRA is not the first effort to improve educational technology through spending. In fact, “billions of dollars have been spent in purchasing, equipping, and supporting” (Norris, Sullivan, Poirot, & Soloway, 2003, p. 15) technology throughout the United States and the world. Financial investments have made it possible for one out of every four students to have computer access (United States Census Bureau, 2008a). Computers themselves, however, do not enhance student learning. For this reason, schools have invested in software packages and networking tools to increase the effectiveness of technology as an instructional device (Tapang, 2002). In mathematics departments alone, schools have devoted money to Mathematics Analysis Software (MAS), which includes statistical and geometry packages, Computer Algebra Systems (CAS), function graphers, and scientific calculators (Pierce & Ball, 2009).

Statement of Problem

In spite of the colossal investment, many educators fail to utilize educational technology. Thomas (2006) estimated that in some industrialized countries, 30% of secondary mathematics teachers never use technology. When technology is employed, research indicates that teachers most commonly utilize it for non-instructional purposes. During their 3-year study conducted in Massachusetts on 2,894 kindergarten through 12th grade (K-12) mathematics teachers, Bebell, Russell, and O'Dwyer (2004) discovered that educators generally prioritize their own needs over those of their students. The National Center for Education Statistics (2010) reported that computers were used by 69% teachers for instructional purposes. On the other hand, computers were utilized by 97% of teachers for school email, by 94% of educators to submit grades, and by 93% of teachers to keep attendance records. This report indicated that teachers were more inclined to utilize computers for administrative purposes than for direct instruction.

Statement of Purpose

The purpose of this collective, instrumental case study was to understand how the attitudes of Algebra 2 teachers influenced the amount of time in which technology was used for instruction. In their technology survey of teachers in 257 government and 199 non-government secondary schools in Queensland, Australia, Goos and Bennison (2008) determined the viewpoints of mathematics teachers with respect to computer software packages, the Internet, and graphics calculators. From their study, the authors postulated that educators with positive attitudes were more inclined to utilize technology than those with negative beliefs. The writers claimed, "It is a mistake to assume that simply supplying schools with hardware and software will increase teachers' use of technology and encourage more innovative teaching approaches" (p. 126). It should be noted that this study relied solely on survey research. Goos and Bennison did not observe any of the teachers to establish whether teacher beliefs influenced educational procedures. Therefore, the purpose of this case study was to discover whether the attitudes of teachers influenced the amount of time in which technology was used for instruction.

Significance of the Study

Several studies have focused on the influence of attitudes on the intent of people to utilize technology (e.g., Lau & Woods, 2008; Venkatesh, Morris, Davis, & Davis, 2003; Teo, 2009). This case study went a step beyond intent and looked at how attitudes impact technology use. The results of this study allow school leaders to have a more thorough understanding of how technology is being employed in schools. From these findings, school administrators can create professional development options designed to increase the likelihood of technology being utilized by the teachers at their schools.

Research Questions

The following questions served as a guide during this study.

Research question one. What attitudes did teachers display with regard to technology? Goos and Bennison's (2008) study demonstrated that teachers develop points of view associated with technology. Therefore, attitudes were established that existed among teachers regarding specific technological devices.

Research question two. How did attitudes influence the amount of time that teachers spent utilizing technology for instruction? In a study from 1996 to 1998 on fifth and sixth grade students in a suburban North Central Texas school district, Hopson, Simms, and Knezek (2001) studied the impact of technology-enriched classes on higher order thinking skills. In their study, the researchers discovered that teachers developed an attitude that technology was beneficial at moving students "beyond knowledge acquisition to knowledge application" (p. 116). As a result, these educators continued using technology for this purpose. This study demonstrated that in some cases, educators are likely to spend more time utilizing technology when they believe it assists students in learning how to apply information. Therefore, I endeavored to find other instances where the attitudes of teachers impacted the amount of time in which technology was employed for instruction.

In an action research study of eight mathematics teachers working in different urban middle schools in the southeastern United States, Swan and Dixon (2006) created a project that allowed the educators to select and receive professional development on one computer program. The technology programs that the teachers chose from were the Florida Comprehensive Assessment Test (FCAT) Explorer, graphing calculator motion detectors, spreadsheets, or any available mathematics programs on computers at their respective schools. From this study, Swan and Dixon discovered that professional development allowed teachers to acquire positive attitudes towards the technology program that they selected. By comparing the computer logs from one year to the next, Swan and Dixon learned that all eight teachers "used the labs more than they had in the previous year" (p. 77). From information given on evaluation forms, the researchers realized that when attending the computer labs, the educators utilized the same programs in which they had received professional development. This study demonstrated that in some cases, teachers spend more time utilizing specific technological resources when positive attitudes are developed. Therefore, I attempted to find additional cases where the attitudes of teachers influenced the amount of time in which certain technological tools were employed for instruction.

Research question three. What did teachers believe were the causes of their attitudes toward technology? The action research project of Swan and Dixon (2006) demonstrated that in some cases, professional development leads to positive attitudes about technology. Therefore, when conducting stimulated recall interviews, I attempted to determine specific causes that led to attitudes associated with technology. The primary purpose of this study, however, was to understand how attitudes impact technology use and not to establish their root causes. Thus, it is important to note that research was not conducted to confirm whether the causes discovered in the interviews were what actually led to the development of attitudes. Rather, the findings served as a preliminary rationale for why teachers hold certain viewpoints. The interview results can also be used as a starting point for future research associated with the origin of attitudes.

Research question four. How did the participants rate their own self-efficacy towards using technology and how did they feel their self-efficacy could be enhanced? Research has shown that personal experience, vicarious learning, goal setting, and hands-on tasks can enhance a person's self-efficacy with regard to using technology (Mackey & Parkinson, 2010; Morales, Knezek, & Christensen, 2008; Wang, Ertmer, & Newby, 2004). With this being the case, an interview was given at the end of the study regarding the participants' beliefs in their ability to employ graphing calculator projectors, interactive whiteboards, and the Internet for instruction. It is important to note that the central purpose of this study was not to determine the participants' self-efficacy when employing technology for instruction. Instead, the purpose was to determine how attitudes toward specific types of technology impacted the amount of time that technology was used for instructional practices. Nonetheless, given that research has shown that improved self-efficacy does increase the likelihood of people using technology, I felt it was necessary to address this topic. By conducting interviews at the end of the study, the participants were given the opportunity to describe methods for enhancing their self-efficacy with regard to using technology. The results of these interviews can assist school leaders in creating professional development to improve the self-efficacy of teachers and increase the likelihood of technology being use for instruction.

Definition of Terms

Technology attitudes. In this study, technology attitudes refer to teacher perceptions about advantages and disadvantages to utilizing technology for instructional purposes. This definition was formulated by Goos and Bennison (2008). The authors discovered that attitudes tend to differ from one educator to the next and suggested that teacher beliefs are linked to their utilization of technology as an instructional tool.

Technology self-efficacy. For the context of this study, teacher self-efficacy was defined as an educator's confidence that he or she can effectively use technology for instruction. According to Bandura (1982), self-efficacy is an individual's belief that he or she can complete certain behaviors. These beliefs are not general in nature, but assigned to specific tasks. It is believed that self-efficacy impacts behavior that people will take part in and how much time and energy they will devote to those activities (Vuorela and Nummenmaa, 2004). For this study, teacher self-efficacy was considered for graphing calculator projectors, interactive whiteboards, and the Internet.

Technology. In 2000, the National Center for Education Statistics (NCES) estimated that approximately half of all teachers used computers to keep administrative records and that half of all educators utilized technology to email parents and colleagues. The NCES also revealed that approximately 20% of all teachers posted homework and other assignments on the Internet and that 85% of educators used the computer to create instructional materials. While each of these items are direct applications of technology, none relate to actual instruction. For this particular study, the sole focus was on technology that was utilized for instruction.

This study concentrated on mathematics teachers. Therefore, technological devices commonly employed in mathematics classes were emphasized. With regard to calculators, the focus was on the amount of time that teachers spent using items that project graphing calculators onto a wall, board, or screen (e.g., Overhead Projector Graphing Calculator Panel, Texas Instrument (TI) Smartview). The amount of time that educators spent teaching from interactive whiteboards was also included in this study (e.g., Smartboards, Promethean Boards). Regarding the computer, the amount of time that teachers spent teaching from the Internet was emphasized.

Research Plan

A review of related literature revealed that many studies have focused on survey based research designed to measure technological attitudes and the intent of people to utilize technology based on these attitudes (e.g., Goos & Bennison, 2008; Lau & Woods, 2008; Venkatesh et al., 2003; Teo, 2009). In each case, the researchers chose not to observe the participants to discover whether technology was being employed. For this reason, the design of this study was a qualitative case study. Case study research allowed me to observe the participants in their natural setting and examine how technology was used in their classrooms (Merriam, 1998). By observing the participants in their instructional settings, I was able to take previous research to the next step and discover how attitudes impacted the amount of time in which technology was used for instruction.

CHAPTER TWO: REVIEW OF THE LITERATURE

The purpose of this case study was to understand how the attitudes of Algebra 2 teachers influenced the amount of time in which technology was used for instruction. This chapter begins with a description of the theoretical framework for the study. The rationale for the selection of this theory and the theory's limitations are also discussed. This chapter continues with an overview of the technological trends in educational research during the 1980s, 1990s, and early part of the 21st Century.

During the classroom observations, my focus was on strategies in which technology was employed for instruction. Therefore, a review of the literature needed to include a synopsis regarding the various strategies for using graphing calculator projectors, interactive whiteboards, and the Internet for instruction. In several instances, the literature was practical rather than research based. However, the goal for this portion of the literature review was to establish specific strategies for employing technology. Therefore, it was necessary to include practical research as it shows how technology can be used for instruction.

The chapter continues with a discussion of articles that focused on technological attitudes and the impact of attitudes on the intent of people to utilize technology. A discussion is also provided regarding the impact of self-efficacy on technology use. This chapter concludes with a summary of the literature review.

Theoretical Background

In the 1960s, a social psychologist named Martin Fishbein (1967) conducted research on the relationship between beliefs and attitudes. In the 1970s, he teamed with

Icek Ajzen and formed the basis for the Theory of Reasoned Action (TRA) (Fishbein & Ajzen, 1975). The theory assumes that behavior has "two conceptually independent determinants of intention: attitudes towards the behavior and subjective norms" (Ajzen, 2000, p. 62). Attitudes represent a person's beliefs about a behavior and the expected outcomes. Subjective norms consist of the perceived social pressures to engage in activities. In general, when attitudes and subjective norms are positive, the likelihood of people taking part in certain behaviors increases.

Since the 1980s, the TRA has been popular among many researchers when trying to predict behavior (Sharma & Kanekar, 2007). Nevertheless, the theory has one significant flaw in that it fails to account for situations where people have little or no control over their decisions (Ajzen, 1991). Obstacles may prevent people from taking part in behaviors even when attitudes and subjective norms are favorable.

Theory of Planned Behavior. As was the case with the TRA, the Theory of Planned Behavior (TPB) takes into account subjective norms and attitudes corresponding to perceived outcomes of behavior. The TPB, however, goes a step further by concentrating on beliefs associated with control (Ajzen, 1991). When people think they have control over a behavior, they are more inclined to take part in that activity. By including the element of control, the TPB provides a more complete theory than the TRA with regard to predicting behavior.

While the TPB provides a more thorough explanation for predicting behavior when compared with the TRA, it does have its limitations. The theory falls short of explaining actual causes of behavior change and it fails to account for demographic, cultural, and personality-related factors that influence behavior (Sharma & Kanekar, 2007). Ogden (2003) argued that in some studies, the roles of attitudes, subjective norms, or behavioral control were not included. Therefore, every element of the theory is not always required to predict behavior. Ajzen and Fishbein (2004) responded to this critique by explaining that the overall nature of attitudes, subjective norms, and behavioral control would vary from one situation and one population to the next.

While there are limitations to the TPB, the theory does provide an appropriate framework for this study. The research focused predominantly on teacher attitudes toward technology. In an effort to minimize differences in the areas of behavioral control and subjective norms, participants were chosen who teach the same course at the same school. Although perceptions concerning behavioral control and subjective norms were considered sparingly, the theory was still appropriate given that these elements often differ from one circumstance to the next (Ajzen and Fishbein, 2004).

Historical Background

Trends in education. During the 1980s and 1990s, researchers forecasted that technology would quickly be implemented into all levels of education due to its rapid evolution in societies throughout the world (e.g., Churchhouse et al., 1986; Kaput, 1992). School systems started formulating curriculum policies that supported the use of technology to enhance student learning. In fact, from October 1993 to October 1997, the number of American students using computers in public schools rose from 68.6% to 79% in grades 1 through 8 and from 58.1% to 70.5% in grades 9 through 12 (National Center for Education Statistics, 1997).

The trend of growing technology use in public schools continued into the 21st century. From 1995 to 2005, the percentage of public schools with Internet access grew from 35% to 100% and the number of computers used for instructional purposes increased from 5,621 to 12,672 (National Center for Education Statistics, 2005). With the increase in technology, educational organizations placed a greater emphasis on technology use with the belief that it enhanced student learning (e.g., National Council of Teaching Mathematics, 2009; United States Department of Education, 2009).

Computers and graphing calculators. As technology use increased in schools during the 1990s, researchers began studying its impact on education. The initial projects focused primarily on the effects of computers and graphing calculators. With computers, researchers concentrated on the influence of the Internet and software packages on such items as academic knowledge, motivation, and self-image (e.g., Christmann, Lucking, & Badgett, 1997; Ryser, Beeler, & McKenzie, 1995). Regarding graphing calculators, researchers examined topics related to teacher pedagogical beliefs about calculator use and whether calculators build connections with course content (e.g., Fine & Fleener, 1994; Guin & Trouche, 1999).

Interactive whiteboards. Although interactive whiteboards were first developed in 1991, it was not until the 21st century that they started becoming commonplace in classrooms (TeachSmart, n.d.). For this reason, research on interactive whiteboards in educational settings is difficult to find prior to the year 2000. Research that has occurred on interactive whiteboards has focused on such items as visual learning and teacher-pupil interactions (e.g., Smith, Hardman, & Higgins, 2006; Tozcu, 2008). Interactive whiteboards were designed to assist teachers in creating lessons and engaging students of all ages and learning styles (SMART, 2009). In 2008, however, *Newsweek* reported that

that only 16% of primary and secondary teachers in the United States had interactive whiteboards in their classrooms (Phillips, 2008).

Utilizing Technology for Instructional Purposes

This section focuses on specific strategies for employing graphing calculator projectors, interactive whiteboards, and the Internet for instructional purposes. In some cases, the literature is practical rather than research based. However, the purpose of this section is to establish specific strategies for employing technology. For this reason, practical research is necessary as it demonstrates how technology can be employed for instruction.

Accessing the Internet through computers. Educators have identified several methods for employing the Internet as an instructional device. For instance, Habash, Suurtaam, Yagoub, Kara, and Ibrahim (2006) provided information regarding online learning through the University of Ottawa, Canada. This online program was presented to high school students interested in pursuing an engineering degree. The purpose was to prepare these learners for the challenges that awaited them upon entering an engineering program in college. Specific modules were created that related to such items as voltage, resistance, power, and energy. Students who enrolled in this program were able to view the modules through the Internet. The modules emphasized mathematical concepts necessary to learn in becoming an engineer. Real world problems were provided to assist these learners in better understanding the field of engineering.

In another case, Forster (2007) conducted a case study in Australia on the use of technology in teaching statistics. Specifically, the researcher wanted to determine how educators utilize technology to teach about trends in the real world. The project focused on a class of 23 twelfth-year students at an all-girls' school. Through classroom observations, the researcher witnessed the teacher using the Internet to find data related to diamond rings. From this information, the instructor created a worksheet that allowed students to create scatter plots using a graphing calculator and make predictions based on the trends observed on their graphs.

Ying-Shao Hsu, Yeong-Jing Cheng, and Guey-Fa Chiou (2003) also conducted a study on how the Internet is used in the classroom. Their project occurred at a high school in Taiwan and the sample consisted of 69 English, biology, earth science, and mathematics teacher, as well as 1,215 sophomores. The project involved case study research, with data being gathered through observations, interviews, and questionnaires. Results indicated that the Internet was utilized to develop instructional materials. In some cases, the teachers presented material directly from the Internet through web-based lessons. Students were also given assignments in which they had to explore the Internet and find information on their own.

In another example, Barabash, Guberman-Glebov, and Baruch (2003) presented methods for training future primary and secondary mathematics teachers to use the Internet in their classrooms. The authors described different modes for teaching and learning through the Internet. In the first case, teachers were expected to use the Internet as an “online classroom” (p. 151). Students were required to read papers, do email assignments, and take part in regular Internet chats. The authors explained that this mode was more theoretical than anything else since most teachers interact with their students on a regular basis. The second method involved instructing students in a face-to-face manner. In this scenario, the Internet was utilized as a “library and a discussion club for students" (p. 153). Teachers were also required to use the Internet to provide guidance to students outside of the formal classroom setting.

Banchoff (2009) conducted a case study and described how Internet-based instruction was used in an honors Multivariable Calculus course at Brown University. The sample consisted of 66 students who took online exams and submitted assignments through the Internet. Teachers were expected to provide feedback on student work in a timely fashion. Student work was posted online for the rest of the class to see unless they requested that their assignments remain private. These postings allowed students to learn from one another. Classmates were permitted to reply to these responses with the hopes of gaining a better understanding of course content.

Banchoff (2009) also explained that students were required to utilize Internet programs that presented Java Applets on the content being taught during face-to-face lectures. These Applets were referred to as "interactive laboratories" (p. 123) as they allowed the class to observe how models changed as data was altered. The Applets permitted students to learn through a secondary source and offered students a means for giving visual representations on their homework assignments.

Graphing calculators. Graphing calculators can also be used by educators for instructional purposes. For instance, Doerr and Zangor (2000) conducted a case study on the use of TI-82 and TI-83 graphing calculators in two pre-calculus classes. These classes had a combined total of 31 students between the ages of 15 and 17 and were taught by an educator with 20 years of teaching experience. Observations were made over three units: linear functions, exponential functions, and trigonometric functions. A minimum of two members of a research team took part in every classroom observation.

Results from these observations indicated that the teacher commonly used graphing calculators to model a problem in both small groups and whole class situations. The educator also used the graphing calculator to extend results, interpret data, make predictions, generalize relationships, and represent the data in meaningful ways.

In another case, Farrell (1996) conducted a case study to determine the types of teaching activities that occurred in pre-calculus courses that utilized graphing calculators. Six teachers were involved in the study and their lessons were videotaped and coded on six different occasions. Results showed that when graphing calculators were not being utilized, the educators maintained the roles of task-setter and explainer. On the other hand, when graphing calculators were employed their roles changed to more of a consultant, resource person, and fellow investigator. The teachers lectured less and allowed their students to take part in more group work.

Simmt (1997) also performed research to determine how six high school mathematics teachers utilized graphing calculators for instruction. The educators in the case study were observed teaching lessons on quadratic functions and then interviewed to determine their attitudes and beliefs regarding mathematics education. Contrary to Farrell's (1996) study, Simmt (1997) found that the teachers did not alter their instructional methods when using graphing calculators. Instead graphing calculators were utilized to provide visual representations of graphs and served to augment lessons. From the visual representations, students were expected to make generalizations about the types of transformations being observed.

Marcee Steele (2006), a professor of special education at the University of North Carolina Wilmington, provided a list of suggestions for implementing graphing calculators in mathematics classes that consisted of children with learning disabilities. Mnemonic strategies can be utilized to assist students in remembering steps and procedures for their calculators. Lessons can be created that force learners to use multiple senses. Such lessons may involve reading a handout, listening to explanations, and asking questions related to graphing calculators. Educators can model problems so that children have an example to follow prior to working on their own. For questions that require a large number of steps, teachers can organize them into smaller increments so that students have less to remember at one time.

Interactive whiteboards. Interactive whiteboards can also be used for instructional purposes. For instance, Karin Nolan (2009), an elementary music teacher in Tuscan, Arizona, discussed a variety of methods that she utilizes to employ interactive whiteboards in her lessons. Ms. Nolan mentioned exposing students to the Internet by projecting websites onto the interactive whiteboard. To assist kinesthetic learners, children are allowed to come to the board and underline or circle words, phrases, and music notes. In an effort to model musical notes, the scales of specific songs are projected onto the whiteboard. When creating prearranged lessons, Ms. Nolan mentioned increasing the font size and underlining or circling key words and phrases to aid visually impaired learners.

In another case, Warwick and Kershner (2008) conducted a study that was a joint research project between the University of Cambridge faculty of Education and the Cambridgeshire Local Authority Information and Communication Technology (ICT) Support and Advisory Service. Seven primary school teachers took part in the study. The project was conducted over 18 months and was conducted in two phases. Phase 1 related to teacher-led, whole class discussions, whereas Phase 2 consisted of students learning through group work. In both phases, the interactive whiteboard was used. Data was collected through observations, focus groups, and reflective writings. Results were only provided for Phase 2.

Evidence in Phase 2 was obtained through "individual written reflective overviews" (Warwick & Kershner, 2008, p. 272). The researchers discovered that teachers often put items on their interactive whiteboard to generate group discussions. In other instances, educators allowed their students to come to the board and "physically re-arrange digits/words/phrases/graphics" (p. 274). Several teachers expressed the desire for their children to take ownership of their work. To accomplish this goal, these educators placed their students into groups of approximately three. With such small groups, each member was able to use the whiteboard in some capacity, and students assigned tasks to themselves without the teacher's involvement. When children came to the board, the educators gave them the freedom to use any tool that the interactive whiteboard provided.

Wood and Ashfield (2008) conducted a case study aimed at answering questions related to how and why teachers utilize interactive whiteboards for instruction. This project consisted of five literacy and five mathematical observations in five different primary schools. The researchers interviewed teachers and conducted focus groups of the students involved in the lessons. During the focus groups, children were asked open-ended questions about the lessons, and the researchers probed further when clarification was required.

Wood and Ashfield (2008) discovered that direct whole-class instruction was commonly utilized when teaching with interactive whiteboards. Teachers modeled and demonstrated how to solve specific mathematics problems. In a literary lesson, one teacher generated questions in which students had to match the appropriate adjective with a given sentence. For visual and auditory learners, the educators occasionally prearranged lessons that included "clip art images and photos, sound, animations, videos, and hyperlinks" (p. 91). In some instances, interactive whiteboards were used to stimulate student interaction. Teachers asked open and closed-ended questions involving both higher and lower order thinking skills. The students rarely worked in small groups and typically played an inactive role during lessons.

In another case, Bennett and Lockyer (2008) conducted a case study to determine how interactive whiteboards were used by four primary school teachers in Australia. All of the educators worked at the same school. The school was located in an upper socioeconomic suburb of a major metropolitan city. Data was collected over two school terms through teacher logs, classroom observations, and interviews. Results showed that during 16 lessons, the teachers and students shared control of the interactive whiteboard. In 11 lessons, the teacher was the sole interactive whiteboard user, and on 1 occasion, the students were the only ones using the board. During the majority of the observations, the teachers first modeled or demonstrated a concept and then let the students attempt a similar problem. The teachers also used the interactive whiteboard to provide instructions or stimulate class discussion.

Preston and Mowbray (2008) provided practical methods for integrating interactive whiteboards in kindergarten classes. Teachers can utilize interactive whiteboards to introduce "a lesson and determine children's prior knowledge and understanding" (p. 51). Students can write on the board when making predictions.

Interactive whiteboards allow teachers to provide instructions in smaller segments. When collecting data, interactive whiteboards permit students and teachers to record their results. Educators can reinforce key points by placing them on the board before class begins. Teachers can also assess student knowledge by providing questions on the board and either having the students answer them from their seats or allowing them to come to the board to give their responses.

Shenton and Pagett (2007) conducted a case study in southwest England to determine how interactive whiteboards are used to teach literacy in six primary school classes. The researchers gathered data through classroom observations and semi-structured interviews of seven year five teachers. Results indicated that the teachers commonly displayed prearranged lessons on their interactive whiteboards to compare and contrast literature or to magnify specific points in a text. Interactive whiteboards were used for playing games or completing multiple-choice assessments. The teachers also allowed their students to come to the board and write answers or gain experience with various whiteboard tools.

Project Specific Information

Teacher attitudes toward technology. From the responses in 485 Teacher Technology Surveys, Goos and Bennison (2008) discovered that 46.4% of mathematics teachers did not think that technology erodes basic math skills, whereas 26.8% were undecided, 24.9% believed that it does, and 11.9% failed to answer the question. The survey also showed that 71.2% of mathematics teachers believed that technology adds to a child's understanding of mathematical concepts, whereas 19.2% were undecided, 7.8% did not, and 1.8% did not give an opinion. This study indicates that teachers have a wide range of attitudes regarding technology. It should be noted that the research did not determine whether these attitudes increased the likelihood of teachers employing technology in an instructional setting.

Attitudes and their impact on behavior. Research on attitudes and their impact on technology usage varies. For instance, Venkatesh et al. (2003) conducted a six month study of four organizations related to entertainment, telecommunications, banking, and public administration. Each company was included in the study because it was introducing new technology in the workplace. The sample consisted of 215 total participants, 119 of whom used technology voluntarily and 96 who were required to use it. Measurements were taken on three different occasions from each corporation: after training employees on the new technology, one month after implementation, and three months after implementation. The purpose of these measurements was to identify specific items that increased the likelihood of technology usage. Regarding attitudes, it was concluded that they do not influence technology use when people are expected to utilize it or their jobs depend on using it. Conversely, intrinsic motivation did play a role in the employees' intent to use of technology.

In another study, Thompson, Higgins, and Howell (1991) conducted survey research in a multinational manufacturing organization on managers and professionals who used personal computers (PC) for their jobs. A total of 455 questionnaires were distributed within the organization with 278 being returned. Anyone who was required to use a PC for his or her job was removed, leaving a total of 212 respondents. Approximately 90% of the participants were male, 70% held undergraduate or graduate degrees, and 60% were between the ages of 30 and 50 with the remainder split between being younger than 30 and being older than 50. Results indicated that attitudes related to the complexity of PC significantly impacted their usage. However, attitudes associated with PC making work more interesting and enjoyable did not significantly influence the respondents' intent to use PC.

In another case, Lau and Woods (2008) administered a web-based survey to college students to determine whether their attitudes and beliefs about supplementary technological devices designed to support traditional face-to-face instruction would increase their intent to use such devices. The volunteer sample consisted of 601 undergraduate students with previous experience using computers and the Internet, 59.7% of whom were male. Approximately 73% of the participants had 3-6 years of computer experience and 72% spent 3-6 hours a day on the Internet. Of the respondents, 120 were removed from the study because they had prior experience with the supplementary technological devices. Results of the survey revealed that attitudes significantly influenced the students' intent to utilize the supplementary devices. Lau and Woods continued their research and discovered that after 3 months of exposure, every student in the study had used the supplementary technology. Of the participants, 19 used the devices one time per week, 81 two or three times per week, 115 four to six times per week, 183 once per day, and 83 more than one time per day. These results showed that attitudes improved toward supplementary technology as students were exposed to these devices. As positive attitudes were formed through exposure, students were more inclined to use supplementary technology.

In another study, Teo (2009) conducted survey research on 442 preservice teachers at the teacher training institute of Singapore. The mean age of these participants was 23.1 years, 74.1% were female, and everyone volunteered to participate. Teo employed the Technology Acceptance Model (TAM) as the theoretical framework of his study to determine whether attitudes influenced the participants' intent to use technology. Results indicated that attitudes did not significantly impact the participants' intent to use technology.

The impact of self-efficacy on technology use. Rather than focusing on teacher attitudes toward specific technological devices, recent studies have concentrated predominantly on self-efficacy associated with using technology. For instance, Curtis, Tanguma, and Pena (2008) conducted research to establish the reliability of a 32-item survey developed from the National Educational Technology Standards for Teachers (NETST). This survey was created to "predict teachers' self-efficacy in using technology for pedagogical purposes" (p. 48). The reliability of this survey was established using elementary school teachers working in a school district in south Texas with 24,568 students, 99% of which were Hispanic. This study occurred during the fall of 2006 and included 360 females and 68 males. The teachers were asked to rate their confidence for undertaking technology related tasks for instructional purposes. Such tasks that were measured included using technology to model ethical practices, applying technology to empower learners, employing technology to support diversity, promoting safe uses of technology, and providing equal access to technology for all students.

The results of this study indicated that the survey has a Cronbach's alpha coefficient of 0.975 (Curtis et al., 2008). Therefore, the survey is a "highly reliable instrument" (p. 56) for measuring the self-efficacy of teachers of Hispanic students regarding their use technology in the classroom.

Watson (2006) looked at the effect of a summer workshop and supplemental online courses on the long-term self-efficacy of teachers. This study included 389 teachers from West Virginia. The participants attended a five day workshop during the summer of 1996 that emphasized email, web searches, downloading files, and integrating the Internet into the classroom. The participants also had the option of registering for an online course that ran from the fall of 1996 through the spring of 1997 and focused on the same elements as the summer workshop.

The Personal Internet Teaching Efficacy Beliefs Scale (PITEBS) was given to the participants in the summer of 1996 and the summer of 1997 (Watson, 2006). Six years after the completion of the online courses another measurement was taken. Of the original 389 participants, 296 continued to work in West Virginia and each of those participants was mailed the PITEBS. Regarding the 296 participants, only 97 returned the mailed survey.

Results of this study indicated that teacher self-efficacy was higher after the participants completed the summer workshop (Watson, 2006). The participants who also enrolled in the online courses were found to have higher levels of self-efficacy when compared to those who only completed the summer workshop. For those who returned the mailed survey six years after completing the online course, it was discovered that they maintained a higher level of self-efficacy when compared to their first measurement in the summer of 2006. However, the PITEBS did not consider external factors which may have contributed to these participants maintaining a higher level of self-efficacy. Therefore, additional factors besides the summer workshop and the online course should be considered with regard to those 97 participants sustaining an increased level of self-efficacy.

In another study, Morales et al. (2008) looked at the self-efficacy of teachers in Mexico City, Mexico and Dallas, Texas. The Technology Proficiency Self-Assessment (TPSA) questionnaire was given to determine teacher self-efficacy when employing technology for instructional purposes. This study included 413 elementary school and 565 middle school teachers from Mexico City and 612 elementary school and 320 middle school teachers from Dallas. The questionnaire was given online to 15% of the teachers in Mexico City and the reminder of the sample completed hard copies of the survey. With regard to the educators in Dallas, every teacher completed the survey through the Internet.

Results of this study indicated that the TPSA is appropriate when examining the self-efficacy differences between teachers in Mexico City and Dallas (Morales et al., 2008). The researchers discovered that teachers in both cities felt proficient with technology associated with designing lessons and incorporating technology in the classroom. On the other hand, the educators in Mexico City were much less confident when using email and the Internet in comparison with the teachers in Dallas.

Chia-Jung and Mei-Yan (2010) used the Human Performance Technology (HPT) theory to investigate the connection between teachers' self-efficacy and task values with their commitment to integrate technology for instruction. A total of 2,952 randomly selected elementary and secondary school teachers from 248 schools in Taipei were included in the study. Questionnaires were delivered to the sample through email, the

Internet, and airmail during January of 2008. A total of 1,195 females and 316 males returned a questionnaire.

The findings showed that teachers who devoted the most time and effort to using technology had more positive beliefs in their ability to use it than teachers who spent less time and energy employing technology (Chia-Jung & Mei-Yan, 2010). Results also indicated that the more the participants valued technology, the greater amount of time they invested in technological devices. In turn, these participants expressed greater self-efficacy than people who placed less value on technology. The study also revealed that older, more experienced teachers spent the least amount of time using technology. As a result, these teachers expressed more negative beliefs in their ability to use technology than younger, less experienced teachers.

In other research, Wang et al. (2004) conducted a study during the spring of 2003 that examined "the impact of vicarious learning experiences and goal setting on preservice teachers' self-efficacy for technology integration" (p 233). Vicarious learning happens when people observe others completing certain tasks. In this study, vicarious learning occurred when the participants' watched other teachers employing technology for instruction. The sample consisted of 280 college students enrolled in an introductory educational technology course at a large university in the Midwestern part of the United States. These students were placed into 18 different lab sections. Each section was assigned to one of four conditions for learning the curriculum: no intervention, setting goals for technology use, vicarious learning experiences, and both goal setting and vicarious learning.

On the first day of class, the students were given a 21-item Likert-scale survey that was designed to measure the self-efficacy of students for integrating technology (Wang et al., 2004). Answer choices ranged from 1 to 4, with 1 representing not confident and 4 being very confident. This survey had a Cronbach's alpha coefficient of 0.94 indicating that it was highly reliable at measuring self-efficacy. The students were given this same survey upon completing of the class.

Results showed that the preservice teachers exposed to only goal setting or only vicarious learning experiences expressed significantly greater opinions about their ability to employ technology for instruction than the students exposed to neither of these interventions (Wang et al., 2004). This study also revealed that preservice teachers exposed to both interventions had significantly greater beliefs about their capacity to use technology than students who received only one of the interventions. The researchers suggested that teacher educators consider using both strategies when assisting preservice teachers in employing technology for instruction.

Mackey and Parkinson (2010) conducted a study that focused on the impact of gender on the self-efficacy of teacher trainees with regard to technology use. Data was collected from a South African university in the city of Durban. A total of 95 students took part in the study. In an effort to "control for extraneous variables, and to ensure similar educational, socioeconomic, and home background among the students were compared" (p. 90), black males were compared with black females and white males were compared to white females. Students were asked to design, construct, and wire a three-roomed doll house. Data was collected through task assessments, questionnaires, interviews, and written reflections.

The study revealed that black and white males had been exposed to tasks similar to the doll house project prior to entering this course, while black and white females had not be exposed to these types of activities (Mackey & Parkinson, 2010). For this reason, the males had greater self-efficacy than the females with regard to completing their doll houses when the study began. However, as the black and white females worked on this hand-on activity, their self-efficacy improved to a level comparable to the black and white males. The researchers suggested that teacher educators in South Africa use hands-on tasks to increase the self-efficacy of preservice teachers toward technology use, especially when working with females.

Jun and Freeman (2010) investigated the manner in which gender influences general computer self-efficacy in college students. The study included 127 female and 116 male undergraduate business students from a medium-sized university. Participation was voluntary and the study consisted of survey research. Two surveys were created and given to the participants. The first survey concentrated on demographic information (age, gender, year at the university) and experiences with computers (computer knowledge, computing experiences, and computer anxiety). This instrument was given during the first two weeks of the class. Regarding the second survey, it focused on general computer self-efficacy and was given two weeks after the first survey. The Social Cognitive Theory (SCT) was used as the theoretical framework for this study.

The findings showed a correlation between gender and computer self-efficacy. Results indicated that females had less confidence with computers because they had taken fewer technology oriented classes and therefore had less practice with technology (Jun & Freeman, 2010). The finds also revealed that females felt greater anxiety when using computers than their male peers. Based on these results, the researchers recommended increasing the experiences, practice, and exposure of females to computers in order to enhance their self-efficacy towards these technological devices.

In other research, Marcinkiewicz (1994) examined the influence of personal factors on teachers using computers as an instructional device. The study included 170 elementary school teachers from an Eastern state. Participants were included if they had computers in their classrooms for at least three years. Data was collected that related to the participants' age, gender, and level of computer experience. Assessments were given to the participants that concentrated on level of use, innovativeness, control over use, and self-competence.

The results of this study showed that self-competence was a significant predictor in the teachers' avoidance or pursuit of using computers (Marcinkiewicz, 1994). While self-competence and self-efficacy are not identical, it was "noted that the shared element of self-efficacy and self-competence is the individual's expectation of competence in controlling personal behavior" (p. 232). When the participants felt competent, they were more likely to use computers for instruction.

Summary

Research affiliated with technology has been prevalent since the 1980s. While most of these studies have focused on computers and graphing calculators, research related to interactive whiteboards became more common in the 21st century. Studies show that educators commonly access the Internet through the computer in order to find data, develop instructional materials, utilize web-based lessons, access online classrooms, employ Java Applets, and respond to student work. Students make use of the Internet to access modules, explore websites, submit assignments, chat with professors, and reply to the work of classmates. With regard to graphing calculators, teachers use them in small group or whole class settings to model problems and provide visual representations that allow students to generalize relationships, make predictions, and interpret data. When utilizing interactive whiteboards, educators employ them to project websites, teach prearranged lessons, provide instructions, stimulate student interaction, and give assessments. Teachers also allow students to come to the interactive whiteboard to circle terms, underline words, write answers, and play games.

Regardless of the topic being studied, researchers have established that people develop certain attitudes related to technology. In spite of this determination, their conclusions vary when considering whether attitudes impact an individual's intent to use technology. Attitudes appear to influence the intent to use technology when social and job expectations are removed and when attitudes are related to the complexity of a technological device. On the other hand, attitudes related to technology making jobs more interesting and enjoyable do not appear to impact a person's intent to employ technology.

Recent studies have focused on the impact of self-efficacy associated with technology use. These studies revealed that females and older, more experienced teachers had more negative beliefs with regard to their ability to use technology than males and younger, less experienced educators. Research also showed that personal experience, goal setting, vicarious learning, and hand-on activities can enhance a person's belief that he or she capable of utilizing technology.

The review of literature revealed that studies have concentrated on technological attitudes and their impact on an individual's intent to utilize technology. However, each study was survey based and included no classroom observations to establish whether attitudes actually led teachers to using technology. Research also showed that improved self-efficacy towards technology increases the likelihood of technology being utilized for instruction. The next chapter consists of the methodology for determining teacher attitudes toward technology and understanding whether those attitudes impacted technology use. The chapter also describes an interview that was created to determine how the participants rated their self-efficacy with regard to employing technology and how they felt their self-efficacy could be enhanced.

CHAPTER THREE: METHODOLOGY

Overview of the Study

This study looked at teacher attitudes toward technology and their impact on the amount of time in which technology is used. Research was conducted in a public, suburban high school northeast of Atlanta, Georgia in a middle to upper class community. Three mathematics teachers at this school were included in the project. These participants took part in a collective, instrumental case study. Data was collected using pre-observational surveys, classroom observations, and stimulated recall interviews. The collected data was coded and categorized for each individual case study. Results of the three cases were compared with one another to determine whether common themes existed.

Research Questions

This study focused on four research questions. These questions were as follows:

Research question one. What attitudes did teachers display with regard to technology? These attitudes were established through a pre-observational survey and two stimulated recall interviews. The details related to this survey and the interviews are discussed in this chapter.

Research question two. How did attitudes influence the amount of time that teachers spent utilizing technology for instruction? The amount of time that technology was used was determined through classroom observations. To discover how attitudes influenced technology use, connections were searched for between the attitudes of the participants and the amount of time that technology was employed.

Research question three. What did teachers believe were the causes of their attitudes toward technology? When an attitude was discussed during the stimulated recall interviews, additional questions were asked to determine what the participants believed to be the root causes of those attitudes.

Research question four. How did the participants rate their own self-efficacy towards using technology and how did they feel their self-efficacy could be enhanced? At the end of the study, an interview was conducted for each participant. The participants rated their self-efficacy towards graphing calculator projectors, interactive whiteboards, and the Internet, explained the rationale for their ratings, and discussed methods for improving their self-efficacy for each technological device.

Design of the Study

The research design was qualitative rather than quantitative. Qualitative studies focus on the perspective of the participant and occur in the participant's natural setting (Merriam, 1998). Researchers search for patterns and interpret data in an effort to find themes. The quest for meaning, ongoing data analysis, and purposeful samples are also associated with qualitative research (Bogdan & Biklen, 2007). Each of these items was included in this study's research design.

Basic research was conducted rather than applied research. In basic research, an individual tries "to expand the frontiers of knowledge without regard to practical application" (Ary et al., 2006, p. 37). Rather than solving an existing problem, the goal was to acquire data associated with how teacher attitudes influence time spent using technology for instruction.

This investigation consisted of case study research. A case study was chosen because I wanted to provide “an intensive description of a phenomenon or social unit such as an individual, group, institution, or community” (Merriam, 2002, p. 8). Case studies consist of “detailed, in-depth data collection involving multiple sources of information rich in context” (Creswell, 1998, p. 61). Bogdan and Biklen (2007) compare case studies to a funnel, in that the researcher initially has a wide view of the project and narrows the study to certain themes as data is accumulated. Case studies also allow researchers to obtain a holistic view of the participants involved in the project.

Case study research is appropriate for this study because it is a bounded system (Merriam, 1998). Creswell (2002) defined a study as being bounded when “the case is separated out for research in terms of time, space, or some physical boundaries” (p. 436). Cases studies can focus on a person, group, school, community, program, event, or activity. As this case study took place in a suburban public school, northeast of Atlanta, GA, the specific boundaries are defined by the three participants who take part in this research project.

Specifically, this study consisted of collective, instrumental case study research. A collective case study provides a general understanding of a number of similar case studies (Stake, 1995). Collective case studies are instrumental because the cases are of secondary interest and the more important issue is a better understanding of “a specific phenomenon, population, or general condition” (p. 437). For this case study, attitudes and their impact on technology use was the issue that was focused upon.

Collective case studies can occur at a single site or multiple locations (Creswell, 1998). For this case study, three participants were purposefully chosen from the same public high school. Data was collected using a pre-observational survey, classroom observations, and stimulated recall interviews. After collecting data, a within-case analysis took place in which specific themes were searched for regarding the impact of attitudes on technology use for each individual case study (Eisenhardt, 1989). As themes were uncovered, a cross-case analysis was utilized to determine whether these themes also existed in the other two case studies. If similar results were discovered, then the findings were likely to be transferable to other educational situations (Merriam, 1998).

Sampling Procedures

Setting. Research was conducted in a suburban school district northeast of Atlanta, Georgia. The system had 154,901 students and 10,241 teachers across all grade levels (Georgia Department of Education, 2008a). Of these children, approximately 41% were economically disadvantaged, 11% were mentally or physically disabled, and 15% were English Language Learners (ELL). Roughly 51% were male, 49% female, 41% Caucasian, 27% African American, 21% Hispanic, 11% Asian, and less than 1% Other. The district contained 125 schools: 72 elementary, 24 middle, 17 high schools, 2 charter schools, 1 online campus, and 9 alternative schools (GCPS, 2009b).

Research took place at one of the public high schools in this system. The high school had 2,628 students, 21% of whom were economically disadvantaged, 9% had disabilities, and 6% were ELL (Georgia Department of Education, 2008b). Of these students, approximately 20% were Asian/Pacific Islander, 17% were African American, 8% were Hispanic, 53% were Caucasian, 3% were Multiracial, and 20% were on the Free and Reduced Lunch program (GCPS, 2009a). This school made Adequate Yearly Progress (AYP) in 2009-2010 school year (Georgia Department of Education, 2010).

The high school had 162 teachers in 12 different departments: Applied Arts, Career and Technical Education, English as a Second Language (ESOL), Health and Physical Education, In School Suspension (ISS), Language Arts, Mathematics, Media, Reserve Officers' Training Corps (ROTC), Science, Social Studies, and Special Education (School Directory, 2009). This school was situated in a community that had a median household income of $66,327 and 9.6% of the population living below the poverty level (United States Census Bureau, 2008b).

Sample selection. Patton (1990) explained that, "Qualitative inquiry typically focuses in depth on relatively small samples, even single cases (n=1) selected purposefully" (p. 169). He elaborated further that, "While studying one or a few cases does not technically permit broad generalizations to all possible cases, logical generalizations can often be made from the weight of evidence produced in studying a single, critical case" (p. 175). Given that qualitative inquires normally include small samples, three participants were purposefully chosen for this study. Logical, rather than broad, generalizations were made due to the small sample size.

The three participants of this study were purposefully chosen through maximum variation sampling. Maximum variation sampling often occurs when research is being conducted on a small sample group and the researcher wants to maximize the diversity relevant to the research question (Patton, 2001). In this case study, the participants were specifically chosen because they had a varying number of years of teaching experience.

The high school where the participants were selected had 24 mathematics teachers (School Directory, 2009). Only the educators who taught Algebra 2 were considered for this study. Of the 24 teachers, only 6 taught Algebra 2. To account for different years of teaching experience, one educator with less than 7 years of teaching experience, one with 7-14 years of teaching experience, and one with 15 or more years of teaching experience was included in the study. Of the six educators who taught Algebra 2, three were Caucasian females with fewer than 7 years of teaching experience, one was a Caucasian male with 7-14 years of teaching experience, and two were Caucasian males with more than 15 years of teaching experience. Regarding the three female teachers with fewer than 7 years of teaching experience, two taught Algebra 2 during the same period as the teacher with 7-14 years of experience. Therefore, those two teachers were eliminated as possible participants in this study. Of the two male teachers with 15 or more years of teaching experience, one was removed as a possibility because he served as a committee member for this study.

Once the three candidates were determined, they were asked to take part in this study. Upon agreeing to participate, each participant was asked to sign an informed consent form (Appendix A). Each participant provided a pseudonym to keep his or her identity confidential throughout the study.

The TPB describes three elements that lead to behavior: attitudes, behavioral control, and subjective norms. By choosing educators from the same school who teach an identical class, several possible differences were eliminated in the participants as they relate to behavioral control. For instance, all three of the participants had a graphing calculator projector, interactive whiteboard, and access to the Internet in their classroom. The participants also taught students of similar intellectual ability. None of the students in their Algebra 2 classes were identified as being gifted and all of their students were 11th graders who had passed Algebra 1 and Geometry. Given that the three participants were Algebra 2 teachers, the content that they taught was identical. The three participants also had access to matching professional development opportunities. Their school required every teacher to take part in 20 hours of professional development each year (GCPS, 2010). With this being the case, the Local School Technology Coordinator (LSTC) created professional development opportunities related to various hardware and software packages throughout the year for every teacher at the school. It is important to note, however, that the professional development that the teachers took part in did not have to concentrate on technology. Instead, it could focus on any area that the teachers wished to improve.

By choosing teachers from the same school, several factors related to subjective norms were also minimized. The three participants had the same principal, administrators, department chair, and coworkers. Therefore, the social pressures to use technology were similar.

Stacey Barber. The first instrumental case study focused on Stacey Barber. Data was collected from Ms. Barber from third week of August through the first week of October in 2010. She was a Caucasian female in her second year of teaching. Ms. Barber was 20-29 years of age, and a bachelor's degree was her highest degree earned. She was not certified to teach students in the ESOL program or who were identified as being gifted, and she did not have her National Board Certification.

Ms. Barber's 7th period Algebra 2 class was observed and it met from 1:18 p.m. to 2:10 p.m. This class consisted of 24 total students, 16 of whom were in general education and 8 who were in special education. With there being eight students who had been identified for special education, a special education teacher assisted Ms. Barber by working specifically with these children. The special education teacher taught none of the mathematics content. Instead, this teacher focused solely on meeting the needs of the eight students who had been identified for special education.

In addition to teaching Algebra 2, Ms. Barber also taught three Geometry classes. Each of the Geometry classes consisted of 10th grade students. She had sixth period planning, which occurred from 12:20 p.m. to 1:12 p.m. Ms. Barber was the only teacher in the school who utilized her classroom. The school where she was observed was the only school that she has ever taught.

James Bryant. The second instrumental case study focused on James Bryant. Data was collected from Mr. Bryant from third week of August through the first week of October in 2010. Mr. Bryant was a Caucasian male in his 11th year of teaching. He was 30-39 years of age, and a specialist's degree was his highest degree earned. Mr. Bryant was not certified to teach students who were identified as being gifted and he did not have his National Board Certification. However, Mr. Bryant was certified to teach students in the ESOL program. Mr. Bryant's 2nd period Algebra 2 class was observed and it met from 8:28 a.m. to 9:20 a.m. The class consisted of 23 general education students.

In addition to teaching Algebra 2, Mr. Bryant also taught three Algebra 1 classes. Each of the Algebra 1 classes consisted of 9th grade students. He had first period planning, which occurred from 7:30 a.m. to 8:22 a.m. Mr. Bryant was the only teacher in the school who utilized his classroom. Prior to teaching at the school where he was observed, Mr. Bryant taught at one other high school in Georgia for ten years.

Peter Clark. The third instrumental case study focused on Peter Clark. Data was collected from Mr. Clark from third week of August through the first week of October in 2010. Mr. Clark was a Caucasian male in his 26th year of teaching. He was 40-49 years of age, and a bachelor's degree was his highest degree earned. Mr. Clark was not certified to teach students in the ESOL program or who were identified as being gifted, and he did not have his National Board Certification. His 1st period Algebra 2 class was observed and it met from 7:30 a.m. to 8:22 a.m. The class consisted of 29 general education students.

In addition to teaching three Algebra 2 classes, Mr. Clark also taught one Geometry class. Each of the Algebra 2 classes consisted of 11th grade students and the Geometry class involved 10th grade students. He had seventh period planning, which occurred from 1:18 p.m. to 2:10 p.m. Mr. Clark was the only teacher in the school who utilized his classroom. Prior to teaching at the school where he was observed, Mr. Clark taught at two other high schools. One of the schools was located in South Carolina and the other was located in Georgia.

Procedures

A specific process was required in order to complete this study. In this section, an overview is provided regarding the steps necessary to carry out this research project.

Committee formation. This study began with the formation of a research committee. Three members were selected to be a part of this committee and their purpose was to provide assistance and feedback throughout the entire study. The first person chosen was the committee chairperson. The two remaining members did not serve as the chair, but were essential in the development of this study.

Proposal. After forming the committee, a proposal needed to be developed to conduct research. This proposal included three chapters. The chapters consisted of the introduction, review of literature, and the study's methodology. This process lasted approximately four months and included several revisions based on the feedback from the committee. Upon completing the first three chapters, a conference call took place which served as a defense to the study's proposal. During this conference call, the research plan was discussed and it was determined that the study was ready to be submitted for approval by the Institutional Review Board (IRB).

IRB approval. Prior to submitting the proposal to the IRB, a local school research request form was completed and given to the secretary of the research site for the principal's signature (Appendix B). Once permission was granted by the principal, the proposal and the local school research request form were submitted to the IRB. The IRB approval process lasted approximately two months. One revision of the study was required. In this revision, a more thorough explanation regarding the security of collected data was needed. Upon completing this revision, the proposal was resubmitted to the IRB and accepted.

Selection of participants. To begin the study, three Algebra 2 teachers were asked to participate in the project. Each teacher was given an informed consent form. The teachers needed to read and sign the form in order to participate in the study. Upon receiving the participants' signed forms, the research process was ready to begin.

Data collection. Data was collected through three different methods: pre-observational surveys, classroom observations, and stimulated recall interviews. To begin the research, each participant was given a 28-item pre-observational survey

(Appendix C). This survey was designed to establish specific attitudes of the participants related to technology. After completing the surveys, they were collected from the participants and stored in a key-locked filing cabinet.

During the next six weeks, each participant was observed teaching one less per week. This allowed for six observations per teacher and a total of 18 classroom observations. Of these six observations, three were announced to the participants ahead of time and three were unannounced. Every classroom observation was videotaped and lasted 52 minutes.

Also, during the six week time-span that the observations took place, the three participants were interviewed two times each. For two of the participants, the interviews occurred after school in their respective classrooms. Regarding the third participant, the interviews took place on the weekend in the football team's field house. Every interview was audio-taped. The only people present during the interviews were the participant and me. These interviews were transcribed and a copy was given to the participants to serve as a member check.

Data analysis. After collecting data through surveys, classroom observations, and interviews, it needed to be analyzed. The surveys and interviews were utilized to determine specific attitudes that the participants had related to technology. Regarding the classroom observations, a stopwatch was used to determine the exact amount of time that technology was employed by the participants.

Once all of the collected data had been analyzed, themes were searched for that related to the impact of attitudes on technology use. This process was done separately for each participant. If themes were discovered for one of the teachers, then a cross-case analysis took place to determine whether these themes existed for all three participants.

Peer review. Any discovered themes were presented to the research committee. The committee members looked over the results and either agreed with the findings or offered suggestions on how to improve the analysis. Once a consensus was reached among the group, the analysis was complete.

Completed manuscript. The results and findings of the study were added to the research proposal in order to complete the manuscript. This process lasted approximately four months and included several revisions based on the feedback from the committee. Upon completing the manuscript, a conference call took place to discuss the findings of the study. During this conference call, the committee agreed that the conclusions were acceptable and that the study was ready to be submitted to the university.

Researcher's Role

In this study, I played an active role in the research process. The pre-observational surveys were given to the participants by me and I conducted all of the stimulated recall interviews. During the classroom observations, I was the person who controlled the video camera. My focus was entirely on the teacher and I attempted to videotape every strategy that was used by the participants when it came to utilizing technology for instruction. When observing the participants, I served as an outside observer and did not assist in instructing their students.

Not only was I the only person who collected data during this study, but I was also the only person who analyzed the data. For this reason, some of my personal biases may have come into play when the data was analyzed. As someone who was also a mathematics teacher with a graphing calculator projector, interactive whiteboard, and access to the Internet in my classroom, I acknowledge that I had certain attitudes toward these technological devices based on my own experiences. Therefore, it is possible that my personal viewpoints regarding technology may have come into play when analyzing the data. In an effort to minimize those biases, teacher responses to a survey and specific quotes from the interviews were used to establish attitudes. Also, a stopwatch was utilized to determine the exact amount of time in which technology was employed for instruction.

I acknowledge that I had a vested interest in this study. Through discussions with other teachers, I had heard that some educators did not utilize technology even when it was present in their classrooms. For this reason, I wanted to determine if there were any reasons why teachers used or failed to utilize technology when it was readily available. As such, my desire to find results may have impacted the way I analyzed the data.

Due to the fact that I am a teacher and unable to leave work during the school day, I chose to conduct research at the same school where I taught. It would have been more ideal to conduct research in a setting where I did not have a relationship with the participants. Regarding Ms. Barber, I knew her for a year prior to including her in this study. With regard to Mr. Bryant, I knew him for three months before he was asked to participate. For Mr. Clark, I knew him for 10 years prior to requesting that he take part in this project.

All three of the participants were colleagues of mine in the math department. However, I also served as the mathematics department chair. This meant that I was the department chair over the three participants. As such, they may have felt unintended pressure to use technology during my classroom observations. However, my role as department chair did not include supervising these teachers or evaluating their performance in the classroom. My department chair duties involved providing encouragement to teachers, supporting teachers during parent conferences, sharing teacher concerns with school administrators, and ordering supplies and textbooks that the teachers in the department needed.

Data Collection

Pre-observational surveys. A 28-item pre-observational survey was utilized to establish teacher attitudes toward technology. This questionnaire included both closed and open-ended questions. The closed-ended questions included all relevant responses and the open-ended ones gave the participants the "freedom to respond from their own frame of reference" (Ary et al., 2006, p. 421).

This survey was researcher developed and was not a published survey. For this reason, permission was not required in order to use the survey. The survey asked attitudinal questions designed to identify specific attitudes related to graphing calculator projectors, interactive whiteboards, and the Internet. A literature review that focused on specific technological attitudes was used develop this survey (e.g., Goos & Bennison, 2008; Venkatesh et al., 2003).

Face and content validity were established by a panel of experts (DeVellis, 1991). These experts included one high school mathematics teachers and two university professors. The high school mathematics teacher was National Board Certified, had a doctorate degree in mathematics education, was a presenter at a Teachers Teaching with Technology Conference, and was a consultant to Cisco Systems for using survey and statistical curriculum. The first university professor earned a doctorate degree in teaching and learning, taught a college level mathematics methods course, and instructed students on how to develop lesson plans through technology. The second university professor earned a doctorate degree in instructional technology education studies, was an assistant professor at Bloomsburg University and taught students who were deaf and hard of hearing through technology-based observations, and conducted case study research with a group of five elementary-aged students to develop team-building skills in a technology dependent society.

To establish face validity, the three professionals were given the completed survey and made recommendations on how to improve its professional appearance to ensure that it looked like a valid testing instrument. As content validity involves "the systematic examination of the test content to determine whether it covers a representative sample of the behavior domain to be measured" (Anastasi & Urbina, 1997, p. 114), the three professionals used their own experiences to study the questions to make certain that they measured attitudes associated with technology. These professionals provided feedback based on their analysis. The survey was not piloted prior to being given to the participants.

The pre-observational surveys included four background related questions. These questions focused on the participants' gender, age, level of teaching experience, and highest degree earned. The remainder of the survey was divided into three sections: graphing calculator projectors, interactive whiteboards, and the Internet. Each section included eight attitudinal statements about the specific type of technology as it related to instruction. Responses were given on a 4-point Likert-scale. Answer options included strongly disagree, disagree, agree, and strongly agree. At the end of each section, the participants had the opportunity to write additional attitudes related to the specific technological device being discussed.

The survey and an envelope were hand delivered to the participants in their classrooms. Participants completed the survey at their own convenience. Upon completing the questionnaire, the participants placed the survey into the envelope and emailed me that they were finished. After collecting the surveys from the participants, they were secured in a key-locked filing cabinet.

Classroom observations. Each teacher was observed six times in an instructional setting for a total of 18 classroom observations. Three of these observations were announced to the participants ahead of time, and three were unannounced. The participants were not observed on days when their students were quizzing or testing. Thus, if an unannounced observation was scheduled on a day when the class was completing an assessment, I came back on another occasion. Each observation was videotaped and lasted 52 minutes. During the observations, I functioned as an outside observer and did not take part in any of the instructional activities. After taping the lessons, the videos were loaded onto a password protected computer and deleted from the camera.

By videotaping the lessons, I was able to review them to determine how technology was utilized for instructional purposes. When watching the videos, a stopwatch was used to determine the exact amount of time that each technological device was employed. As technological devices can be utilized in a variety of ways, a stopwatch was used to determine the amount of time that the participants spent employing each instructional method (e.g., how much time did students spend using the interactive whiteboard, how much time did the teachers spend using the interactive whiteboard). By using a stopwatch, observations were quantified in an effort to reduce researcher bias.

While a specific observation protocol was not developed, I did observe all of the participants one time per week. Therefore, three observations took place every week for six consecutive weeks. At the end of this six week period, the 18 classroom observations were completed. During the classroom observations, a camera was used to videotape the lessons. As the participants moved about their classroom, the camera focused on them and the instructional strategies they were utilizing. At no point was the camera left unattended during the classroom observations. Therefore, no descriptive or reflective notes were taken during these observations.

Stimulated recall interviews. One of the announced and one of the unannounced classroom observations was selected to view with each participant. As the participant and I reviewed a video, an interview took place through stimulated recall (Schepens, Aelterman, & Van Keer, 2007). The video was started, and as technology was utilized, I stopped the tape and asked the participant questions to gain a deeper understanding as to why technology was employed in that capacity. The questions also focused on technological attitudes and what the participants believed to be the root causes of those attitudes. A "loose interview guide" (Bogdan & Biklen, 2007, p. 106) was utilized in each interview. While there was some structure to these interviews, the larger goal was gaining understanding of teacher attitudes toward technology and the root causes of these attitudes. These questions were not scripted ahead of time as the questions were based off of what was observed in the videos. Follow up questions were also asked and were based on the participants' responses.

As there were three participants in this study, a total of six stimulated recall interviews took place. For two of the participants, the interviews occurred in their classrooms. For the third participant, those interviews took place in the football team's field house. No one was present except for the participant and me during these interviews. Each interview was audio-taped and transcribed. Electronic copies of the transcriptions remained on a password protected computer, and hard copies were kept in a key-locked filing cabinet. After transcribing the interviews, the participants were allowed to read the transcriptions to ensure that the responses were accurate. This process served as a member check.

Self-efficacy interviews. Research has shown that personal experience, vicarious learning, goal setting, and hands-on activities can enhance a person's self-efficacy associated with using technology (Mackey & Parkinson, 2010; Morales et al., 2008; Wang et al., 2004). With this being the case, the participants were given an interview at the end of the study regarding their self-efficacy towards using technology for instruction. Each participant rated their self-efficacy towards graphing calculator projectors, interactive whiteboards, and the Internet. These ratings were from 1 to 4, with 1 representing not confident, 2 denoting somewhat confident, 3 characterizing confident, and 4 symbolizing very confident. The participants also discussed the rationale for their ratings and described methods for improving their self-efficacy for each technological device.

Merton and Kendall (1946) explained that some interviews are predominantly open-ended, but focused around specific topics. Whyte (1979) called these types of interviews "flexibly structured" (p. 57) as the questions are structured to keep the interview on track, but also allow the interviewer "to recognize statements which suggest new questions" (p. 57). For this case study, flexibly structured interviews were utilized for rating the self-efficacy of the participants toward graphing calculator projectors, interactive whiteboards, and the Internet. The interviews also gave the participants an opportunity to discuss strategies for enhancing their self-efficacy regarding the use of technology for instruction.

These interviews consisted of 23 structured questions (Appendix D). The structured questions were focused on the three technological devices emphasized in this study and concentrated on specific strategies that research has shown to be effective at enhancing self-efficacy. Morales et al. (2008) showed how personal experiences can improve self-efficacy. Wang et al. (2004) described how vicarious learning and goal setting can boost self-efficacy. Mackey and Parkinson (2010) discussed how completing hands-on tasks can increase self-efficacy.

For this study, self-efficacy was defined as a person's confidence that he or she can use technology for instructional purposes. As confidence can have various meanings to different people, the first question of the structured interview asked the participants to define self-confidence in terms of using technology for instruction. The purpose of this question was to establish the vantage point of the participants when they discussed self-confidence with regard to employing technology for instruction.

Regarding the remaining structured interview questions, seven focused on graphing calculator projectors, seven concentrated on interactive whiteboards, and seven were directed towards the Internet. The final question gave the participants the opportunity to discuss the strategies that they felt would be most effective at enhancing their self-efficacy associated with using these three types of technology in the classroom. The interviews were audio-taped and transcribed. Copies of the interview transcriptions were given to the participants to serve as a member check. These interviews took place in the participants' classrooms and the only people present were the participants and me.

The structured questions were given to one high school mathematics teacher and two university professors prior to being dispensed. These were the same professors and teacher who offered their assistance in the validation process of the pre-observational survey. Insight was provided by these individuals with regard to the wording of the questions and they determined whether questions should be added or removed. Once a consensus was reached, the structured interview was ready to be administered.

Audit trail. Throughout the data collection process, a detailed timeline was kept regarding the techniques of data collection and the rationale for choosing such methods. By keeping an audit trail, a "third-party auditor can examine the inquirer's study in order to attest to the dependability of procedures employed and to examine whether findings are confirmable" (Ary et al., 2006, p. 509).

Analysis Procedures

After collecting the data, the material was broken down into pre-developed categories through open coding (Stake, 1995). The pre-developed categories were determined by the three specific types of technology being observed: graphing calculator projectors, interactive whiteboards, and the Internet. Within each category, axial coding was conducted by looking at the manner in which each technological device was employed (Wolcott, 1994). A coding list was generated for the possible ways in which technology could be implemented for instruction (Appendix E). This list was generated from a literature review, my own background knowledge, and the knowledge of one high school mathematics teacher and two college professors. This list was completed prior to analyzing the data. However, if during the classroom observations and stimulated recall interviews other instructional methods were discovered, then those strategies were added to the list.

Once the list was created, each method was numbered and used in the coding process (e.g., A1-Teachers Access Modules to Online Programs, A2-Teachers Develop Instructional Materials Using the Internet, A3-Teachers Find Internet Data). The classroom observations were coded using this list. On a table for coding classroom observations (Appendix F), the exact amount of time was written that each strategy was used. There was also a section at the bottom of this table for adding descriptive notes related to the classroom observation being watched.

The pre-observational surveys and the stimulated recall interviews were used to determine the attitudes of each participant as they related to the three technological devices. From these attitudes, connections were looked for that related to teacher beliefs and the amount of time spent utilizing technology. This procedure was done separately for each participant. After coding all of the information, a cross-case analysis was conducted to identify common themes between the three participants as they related to each type of technology (Merriam, 1998).

If themes were uncovered among the participants, then a peer review was conducted by asking one high school mathematics teacher and two university professors to verify that the conclusions were acceptable. These were the same professors and teacher who provided assistance in the validation process of the pre-observational survey. If the group felt that additional themes were present, then the appropriate changes were made. Once a consensus was reached among the group, the credibility of the findings was enhanced.

Trustworthiness

The trustworthiness of this study was addressed through the credibility, dependability, transferability, and confirmability of the findings.

Credibility. Credibility is one factor in establishing trustworthiness. In this case study, credibility was enhanced through methods triangulation. According to Guba (1981), using different methods to collect data allows researchers to counteract the limitations of specific methods and take advantage of their respective benefits. In this case study, data was collected through pre-observational surveys, classroom observations, and stimulated recall interviews.

Guba (1981) also mentioned that having peers analyze findings enhances credibility. In this case study, a peer review was conducted on the themes discovered during the data analysis process. This peer review increased the credibility of the research findings.

Member checks are another way to bolster the credibility of research (Brewer & Hunter, 1989). In this case study, the participants were allowed to review the transcribed interviews. By reading the interview transcriptions, the participants were given the opportunity provide feedback regarding the accuracy of the interviews.

Dependability. Dependability considers "if the work were repeated, in the same context, with the same methods and with the same participants, similar results would be obtained" (Shenton, 2004, p. 71). One way to increase dependability is through triangulation (Krefting, 1991). By getting the same results through multiple sources, the dependability of the findings is enhanced. For this case study, specific attitudes were described in both the pre-observational surveys and the stimulated recall interviews. Also, by conducting six different classroom observations for each participant, certain strategies for employing technology were observed on more than one occasion.

Dependability of research is also enhanced when a detailed description of a study's methodology is provided (Guba, 1981). When the methodology is rigorously described, the study can be replicated. Regarding this study's methodology, the research design was described, specific procedures were outlined from the beginning to the end of this study, the process for gathering data was given with regard to the pre-observational surveys, classroom observations, and stimulated recall interviews, and the methods for analyzing the data were presented.

Transferability. Transferability looks at the degree in which the findings of one study can be applied to other situations. To increase the likelihood of the findings of this study being transferred to other settings, a cross-case analysis was conducted (Merriam, 1998). Specific themes were searched for within each individual case study. If themes were identified, then they were compared to the other two individual case studies to determine whether common themes existed. When common themes were discovered for all three case studies, those themes were likely to be transferable to other educational settings. Logical, rather than broad, generalizations were made due to the small sample size (Patton, 1990).

Confirmability. Confirmability looks at the degree in which a study is free from bias (Patton, 1990). Guba (1981) claimed that admitting to a study's shortcomings, describing researcher biases, and triangulating research methods are three ways to enhance confirmability. In this case study, the study's limitations are discussed in detail in Chapter 5 and personal biases were discussed earlier in this chapter. Also, data was collected from three different methods: a pre-observational survey, classroom observations, and stimulated recall interviews.

Ethical Considerations

In an effort to protect the participants, ethical considerations were considered when creating this study. A pseudonym was assigned to each of the participants to keep their identity confidential. The participants also completed an informed consent form and a pre-observational survey. In an effort to prevent these documents from being lost or viewed by someone other than the participants and me, they were stored in a key-locked filing cabinet. Classroom observations were coded on a classroom observation coding table and interviews were transcribed. The hard copies of these documents were also kept in a key-locked filing cabinet, while the electronic copies were stored on a password-protected computer. There were 18 videotapes of the classroom observations. These videos were saved onto a password protected computer and deleted from the camera. As each of the stimulated recall interviews were audio-taped, these tapes were secured in a key-locked filing cabinet.

CHAPTER FOUR: ANALYSIS OF DATA

The purpose of this study was to determine how attitudes impact the amount of time that teachers spend utilizing technology. This project focused on three aspects of technology: graphing calculator projectors, interactive whiteboards, and the Internet. Three high school mathematics teachers participated in the study. To maintain anonymity, a pseudonym was provided for each teacher. A pre-observational survey and stimulated recall interviews were used to establish teacher attitudes. To determine the amount of time that teachers spend employing technology, educators were videotaped teaching six different lessons. After recording these lessons, the videos were watched and specific methods in which technology was utilized were identified. As techniques were employed, a stopwatch was used to determine the length of time that these procedures were used.

This chapter begins with a restatement of the research questions as a reminder of the direction of this study. Teacher attitudes are discussed as they relate to technology. A description is given of the exact amount of time that technology was employed by the participants. Themes related to the impact of attitudes on the amount of time that technology is used are also described. The chapter continues with an analysis of what the participants believed to be the root causes of specific technological beliefs. This chapter concludes with a description of how the participants rated their self-efficacy with regard to using technology for instruction and what strategies they felt could enhance their self-efficacy.

Research Questions

Four research questions guided this study. These questions were as follows:

Research question one. What attitudes did teachers display with regard to technology? This question focused on the specific attitudes that each participant expressed regarding graphing calculator projectors, interactive whiteboards, and the Internet. Viewpoints were discovered from the pre-observational surveys and the stimulated recall interviews.

Research question two. How did attitudes influence the amount of time that teachers spent utilizing technology for instruction? To answer this question, results were provided regarding the amount of time that each teacher utilized technology. These times came directly from the classroom observations. Results are presented for the six observations of each participant. The total amount of time that the participants employed technology is also provided. After discussing the times, themes are described regarding the impact of attitudes on the amount of time that technology was utilized by the participants.

Research question three. What did teachers believe were the causes of their attitudes toward technology? This question focused on the participants' beliefs regarding the root causes of their attitudes toward technology. Results for this question came from the stimulated recall interviews. It is important to note that research was not conducted to confirm whether these beliefs actually led to specific attitudes towards technology. The findings merely serve as a preliminary rationale for why teachers hold certain viewpoints.

Research question four. How did the participants rate their own self-efficacy towards using technology and how did they feel their self-efficacy could be enhanced?

This question focused on the participants' perspective on their self-efficacy towards employing technology for instruction. The question also gave the participants an opportunity to express how they believed their self-efficacy could be improved. It is important to note that research has already shown that people with positive beliefs about their ability to use technology are more likely to use it than those with negative beliefs (e.g., Mackey & Parkinson, 2010; Morales et al., 2008; Wang et al., 2004). Therefore, this study concentrated on attitudes and their impact on technology use as opposed to self-efficacy. However, I did feel that it was important to discuss the participants' self-efficacy and how they thought it could be enhanced since research has shown a correlation between self-efficacy and behavior.

Research Question One

The attitudes of the three participants were discovered through a pre-observational survey and two stimulated recall interviews. This survey included three sections which focused on items that project graphing calculators (e.g., Overhead Projector Graphing Calculator Panel, TI-Smartview), interactive whiteboards (e.g., Smartboards, Promethean Boards), and the Internet. Each section included eight attitudinal statements with answer choices of strongly disagree, disagree, agree, and strongly agree. At the end of each section, the participants had the opportunity to write additional attitudes related to the specific technological device being discussed.

With regard to the stimulated recall interviews, the participants and I watched the classroom observations together. As technology was employed, the video was stopped and questions were asked. In some instances, these questions led to the revelation of additional technological attitudes. If a specific technological device was not utilized, then supplementary viewpoints were not discovered.

Stacey Barber's attitudes toward items that project graphing calculators. Of the eight attitudinal statements regarding graphing calculator projectors, Ms. Barber strongly disagreed with one statement, disagreed with three statements, agreed with four statements, and strongly agreed with none of the statements. Ms. Barber strongly disagreed that graphing calculator projectors require substantial preparation time for use. She disagreed that graphing calculator projectors increase student motivation in mathematics, allow students to gain a deeper understanding of course content, and promote laziness in student work. Ms. Barber agreed that graphing calculator projectors provide students with visual representations that are necessary for student learning, increase student enjoyment in mathematics, encourage interaction between the student and the teacher, and can easily be employed during instruction. She did not provide any additional attitudinal statements regarding graphing calculator projectors.

Additional attitudes related to graphing calculator projectors were revealed through two stimulated recall interviews. The first stimulated recall interview focused on the fifth classroom observation. This observation was announced to Ms. Barber ahead of time and concentrated on using matrices to solve systems of equations. The second stimulated recall interview was associated with the second classroom observation. This observation was unannounced and emphasized linear programming. In the two interviews, Ms. Barber spoke specifically about TI-Smartview when discussing graphing calculator projectors.

During the first stimulated recall interview (Stacey Barber, personal communication, September 23, 2010), Ms. Barber revealed specific attitudes as they relate to TI-Smartview. As a visual representation she stated, “I just think it’s a good visual for students on how to use their calculator.” Ms. Barber discussed attitudes about TI-Smartview as a modeling device. She claimed, “I like the Smartview because students can physically see me pressing the buttons and see the list of key presses.” Ms. Barber also explained that TI-Smartview allows students to learn more about graphing calculators, “especially the ones who don’t have one or who are just new to getting one.”

In the second stimulated recall interview (Stacey Barber, personal communication, September 30, 2010), Ms. Barber elaborated further on her viewpoints about TI-Smartview. She claimed that Smartview is helpful for modeling problems, “even when they need to know how to type something in for order of operations it is so nice to be able to show them how to type it on the calculator.” When discussing the visual representation of a system of inequalities, she stated, “I think it helps to see the shading and then taking it away and trying to figure it out on your own.” Regarding the time it takes to load TI-Smartview, Ms. Barber expressed one viewpoint by saying, “It takes like 30 seconds to load which is annoying when you’re sitting there.” She explained further that “sometimes when you type quickly, Smartview doesn’t keep up with you so that’s hard.”

Stacey Barber’s attitudes toward interactive whiteboards. Of the eight attitudinal statements related to interactive whiteboards, Ms. Barber strongly disagreed with two statements, disagreed with one statement, agreed with two statements, and strongly agreed with three statements. Ms. Barber strongly disagreed that interactive whiteboards are difficult to operate and require substantial preparation time for use. She disagreed that interactive whiteboards are helpful when teaching students who speak different languages. Ms. Barber agreed that interactive whiteboards increase student motivation and enjoyment in mathematics. She strongly agreed that interactive whiteboards provide students with visual representations that are necessary for student learning, are helpful when teaching students with different learning styles, and allow teachers to enrich their lessons. Ms. Barber did not provide any additional attitudinal statements regarding interactive whiteboards.

The interactive whiteboard that Ms. Barber used was a Smartboard. Therefore, in the two stimulated recall interviews, she spoke specifically about Smartboards when discussing interactive whiteboards.

In the first stimulated recall interview (Stacey Barber, personal communication, September 23, 2010), Ms. Barber revealed specific attitudes as they relate to Smartboards. Ms. Barber claimed that the Smartboard is useful because it helps to "minimize distractions." She stated that she prefers to start her classes by projecting a problem or directions on the Smartboard to establish a routine for her students. Ms. Barber maintained that "it helps, I think, for them to do the same thing every day." She also declared that she prefers a Smartboard over a dry-erase board because "the Smartboard is more of an eye catcher" and with the Smartboard she can "save work."

In the second stimulated recall interview (Stacey Barber, personal communication, September 30, 2010), Ms. Barber elaborated further on her viewpoints about Smartboards. When discussing the ease of searching for graphics such as a timer in the Smartboard's database, she said, "I just type in timer and it pops up and I pull it out."

Ms. Barber also claimed that projecting handouts or notes on the Smartboard allows her to “move at a faster pace.”

Stacey Barber’s attitudes toward the Internet. Of the eight attitudinal statements related to the Internet, Ms. Barber strongly disagreed with none of the statements, disagreed with five statements, agreed with three statements, and strongly agreed with none of the statements. Ms. Barber disagreed that the Internet allows teachers to enrich their lessons, is helpful when introducing a new topic, increases student enjoyment in mathematics, allows students to gain a deeper understanding of course content, and requires substantial time to locate appropriate websites. She agreed that the Internet enhances student critical thinking skills, increases student motivation in mathematics, and allows teachers to meet the individual needs of more students. Ms. Barber did not provide any additional attitudinal statements regarding the Internet.

The stimulated recall interviews focused on two classroom observations. In neither of these lessons was the Internet utilized. Therefore, Ms. Barber did not reveal any additional attitudes regarding the Internet.

James Bryant’s attitudes toward items that project graphing calculators. Of the eight attitudinal statements associated with graphing calculator projectors, Mr. Bryant strongly disagreed with none of the statements, disagreed with one statement, agreed with three statements, and strongly agreed with four statements. Mr. Bryant disagreed that graphing calculator projectors promote laziness in students. He agreed that graphing calculator projectors provide students with visual representations that are necessary for student learning, encourage interaction between the student and the teacher, and require substantial preparation time for use. Mr. Bryant strongly agreed that graphing calculator projectors increase student motivation and enjoyment in mathematics, allow students to gain a deeper understating of course content, and can easily be employed during instruction. He did not provide any additional attitudinal statements regarding graphing calculator projectors.

Additional attitudes related to graphing calculator projectors were revealed through two stimulated recall interviews. The first stimulated recall interview focused on the third classroom observation. This observation was announced to Mr. Bryant ahead of time and concentrated on using operations of matrices to solve matrix equations. The second stimulated recall interview was associated with the fourth classroom observation. This observation was unannounced and emphasized using Cramer's Rule to solve systems of equations. In the two interviews, Mr. Bryant spoke specifically about TI-Smartview when discussing graphing calculator projectors.

In the first stimulated recall interview (James Bryant, personal communication, September 10, 2010), Mr. Bryant revealed specific attitudes as they relate to TI-Smartview. At the beginning of the school year, Mr. Bryant assigned a number to every student in his class. By using TI-Smartview, Mr. Bryant stated that he is capable of randomly selecting their numbers in order to "get kids to the board." He claimed that randomly selecting students "keeps the kids on their toes" and inhibits them from "fading out" during class.

In the second stimulated recall interview (James Bryant, personal communication, October 5, 2010), Mr. Bryant elaborated further on his viewpoints about TI-Smartview. As a visual representation, he stated that TI-Smartview is "so much nicer than other programs because you can make graphs larger." Mr. Bryant claimed that TI-Smartview is beneficial when modeling problems because “you can show every single step, you know every button that you pressed.” He mentioned that modeling problems through TI-Smartview also benefits students who own non-graphing TI calculators because “I can show them in Smartview and it looks similar enough to theirs.” When discussing the time it takes to load TI-Smartview, Mr. Bryant said, “There’s always a good twenty to thirty second delay before it actually opens.” He explained further that “every now and then there’s that delay, where you press a button and wait.”

James Bryant’s attitudes toward interactive whiteboards. Of the eight attitudinal statements related to interactive whiteboards, Mr. Bryant strongly disagreed with none of the statements, disagreed with one statement, agreed with one statement, and strongly agreed with six statements. Mr. Bryant disagreed that interactive whiteboards are difficult to operate. He agreed that interactive whiteboards require substantial preparation time for use. Mr. Bryant strongly agreed that interactive whiteboards provide students with visual representations that are necessary for student learning, increase student motivation and enjoyment in mathematics, are helpful when teaching students with different learning styles, are helpful when teaching students who speak different languages, and allow teachers to enrich their lessons. He did not provide any additional attitudinal statements regarding interactive whiteboards.

The interactive whiteboard that Mr. Bryant used was a Smartboard. Therefore, in the two stimulated recall interviews, he spoke specifically about Smartboards when discussing interactive whiteboards.

In the first stimulated recall interview (James Bryant, personal communication, September 10, 2010), Mr. Bryant revealed specific attitudes as they relate to

Smartboards. With regard to the time it takes to create lessons on the Smartboard, Mr. Bryant stated, “Once you do learn how to use it, it is so much faster and it’s easier to manipulate.” When discussing the time it takes to refer back to something taught earlier in the class period, Mr. Bryant claimed, “It is really nice to be able to bounce back and forth so quickly.” Mr. Bryant explained that he prefers Smartboards over dry-erase boards because “the visuals on the Smartboard are much more powerful.” He also mentioned that Smartboards enable him to save work by saying, “I literally save it,” and “I wouldn’t be able to do nearly as much if I didn’t already have it created.”

In the second stimulated recall interview (James Bryant, personal communication, October 5, 2010), Mr. Bryant elaborated further on his viewpoints about Smartboards. Mr. Bryant declared that creating lessons on the Smartboard “is so much easier and more powerful” than generating lessons without it because he can “capture” items directly from the book to include in his lessons. He also stated that challenges exist when solving problems on the Smartboard when compared to a dry-erase board. Mr. Bryant argued, “You can have an entire problem on the board, but it might take four or five slides on the Smartboard.”

James Bryant’s attitudes toward the Internet. Of the eight attitudinal statements related to the Internet, Mr. Bryant strongly disagreed with none of the statements, disagreed with none of the statements, agreed with six statements, and strongly agreed with two statements. Mr. Bryant agreed that the Internet enhances student critical thinking skills, allows teachers to enrich their lessons, increases student motivation and enjoyment in mathematics, allows students to gain a deeper understanding of course content, and requires substantial time to locate appropriate websites. He strongly agreed that the Internet is helpful when introducing a new topic and allows teachers to meet the individual needs of more students. Mr. Bryant did not provide any additional attitudinal statements regarding the Internet.

In the first stimulated recall interview (James Bryant, personal communication, September 10, 2010), Mr. Bryant revealed other attitudes as they relate to the Internet. He mentioned that the Internet provides him with an avenue for "posting the lessons" he has created on the Smartboard. His entire lessons are posted, and he asserted, "I think it's good for students, especially students who are like me. I was not as organized as I am now when I was in high school. I wouldn't be able to read my own notes." Mr. Bryant expressed that the time it takes to post his lessons to the Internet is minimal by stating, "It might take me two minutes to do it every day."

In the second stimulated recall interview (James Bryant, personal communication, October 5, 2010), Mr. Bryant elaborated further on two viewpoints associated with the Internet. With regard to the challenges of using the Internet during class, Mr. Bryant stated that while he believes some websites are beneficial to student learning, "finding a way to use them in a way that I think is meaningful is hard for me." Mr. Bryant also mentioned that "finding the time to plan is one of my biggest issues" when trying to utilize the Internet as an instructional device.

Peter Clark's attitudes toward items that project graphing calculators. Of the eight attitudinal statements regarding graphing calculator projectors, Mr. Clark strongly disagreed with one statement, disagreed with one statement, agreed with two statements, and strongly agreed with four statements. Mr. Clark strongly disagreed that graphing calculator projectors require substantial preparation time for use. He disagreed that graphing calculator projectors promote laziness in students. Mr. Clark agreed that graphing calculator projectors encourage interaction between the student and the teacher and allow students to gain a deeper understanding of course content. He strongly agreed that graphing calculator projectors provide students with visual representations that are necessary for student learning, increase student motivation and enjoyment in mathematics, and can easily be employed during instruction. Mr. Clark did not provide any additional attitudinal statements regarding graphing calculator projectors.

Additional attitudes related to graphing calculator projectors were revealed through two stimulated recall interviews. The first stimulated recall interview focused on the fourth classroom observation. This observation was unannounced and concentrated on using Cramer's Rule to solve systems of equations. The second stimulated recall interview was associated with the fifth classroom observation. This observation was announced to Mr. Clark ahead of time and consisted of a review of the rules required to find the equation of a circle. In the two interviews, Mr. Clark spoke specifically about graphing calculator panels when discussing graphing calculator projectors.

In the first stimulated recall interview (Peter Clark, personal communication, September 19, 2010), Mr. Clark revealed specific attitudes as they relate to graphing calculator panels. He mentioned that utilizing a panel to expose students to graphing calculators is a way "to support what they already know." Mr. Clark claimed that graphing calculator panels benefit students because they allow him to "expand their universe in the mathematical world." He stated that panels give him the power to "teach how to use technology correctly." These devices also permit Mr. Clark to "show another way of graphing functions" and to "review graphs" discussed in the past.

In the second stimulated recall interview (Peter Clark, personal communication, October 3, 2010), Mr. Clark elaborated further on his viewpoints about graphing calculator panels. When modeling problems, Mr. Clark stated that graphing calculator panels allow him to "actually hold a concrete item in my hand that they have in their hand and I'm punching the same buttons that they are." He mentioned, "if you want to teach them how to use a calculator you've got to have a calculator." Regarding expectations, Mr. Clark claimed that graphing calculator panels "make them accountable for the fact that I've taught them how to use something and they need to go ahead and start doing it." As technology is prevalent in the modern world, Mr. Clark said that panels enable him to "connect to kids" and "present the material in a better way." These devices also allow him to present a "shortcut" when completing specific types of problems.

Peter Clark's attitudes toward interactive whiteboards. Of the eight attitudinal statements related to interactive whiteboards, Mr. Clark strongly disagreed with none of the statements, disagreed with two statements, agreed with one statement, and strongly agreed with five statements. Mr. Clark disagreed that interactive whiteboards are difficult to operate and require substantial preparation time for use. He agreed that interactive whiteboards increase student enjoyment in mathematics. Mr. Clark strongly agreed that interactive whiteboards provide students with visual representations that are necessary for student learning, increase student motivation in mathematics, are helpful when teaching students with different learning styles, are helpful when teaching students who speak different languages, and allow teachers to enrich their lessons. He did not provide any additional attitudinal statements regarding interactive whiteboards.

The light bulb was dim on the projector that connects with Mr. Clark's Smartboard. As a result, students were unable to view anything on the Smartboard. For this reason, Mr. Clark used the television and overhead projector as interactive whiteboards. Therefore, in the two stimulated recall interviews, Mr. Clark spoke specifically about how he uses the television and overhead projector as interactive devices when discussing interactive whiteboards.

In the first stimulated recall interview (Peter Clark, personal communication, September 19, 2010), Mr. Clark revealed two attitudes as they relate to overhead projectors as an interactive device. With regard to projecting handouts, Mr. Clark expressed that he is able to "build on a concept" and "show them or model for them" the process of solving problems.

In the second stimulated recall interview (Peter Clark, personal communication, October 3, 2010), Mr. Clark elaborated further on his viewpoints about televisions as an interactive device. By reviewing previously prepared PowerPoint presentations and projecting them on the television, Mr. Clark explained that he can re-examine material that will "show up on the midterm and final exam." He argued that reviewing these notes allows him to "fill in the gaps" for students who do not recall portions of previously taught course content. Mr. Clark also derived mathematical formulas by writing directly on the television screen using an erasable marker. He claimed that these derivations teach students "where rules come from" and demonstrate how "it fits into the world that we live in."

Peter Clark's attitudes toward the Internet. Of the eight attitudinal statements related to the Internet, Mr. Clark strongly disagreed with one statement, disagreed with none of the statements, agreed with none of the statements, and strongly agreed with seven statements. Mr. Clark strongly disagreed that the Internet requires substantial time to locate appropriate websites. He strongly agreed that the Internet enhances student critical thinking skills, allows teachers to enrich their lessons, is helpful when introducing a new topic, increases student motivation and enjoyment in mathematics, allows students to gain a deeper understanding of course content, and allows teachers to meet the individual needs of more students. Mr. Clark did make two comments regarding issues that the Internet presents. He claimed that "students who used to forget their pencils, now misplace passwords." Mr. Clark also mentioned that issues exist when students search for "inappropriate websites."

In the first stimulated recall interview (Peter Clark, personal communication, September 19, 2010), Mr. Clark revealed two attitudes related to showing video clips from the Internet. Mr. Clark claimed that these video clips allow him to supplement the course content. He argued that "the more times that students hear the material, the more times it is possible for them to pick it up." Mr. Clark also mentioned that these videos "expose students to opportunities where they can learn beyond the classroom."

In the second stimulated recall interview (Peter Clark, personal communication, October 3, 2010), Mr. Clark elaborated further on his viewpoints about the Internet. He claimed that employing the Internet is important because "it's in the students' world." As Mr. Clark's students were born into a world in which the Internet already existed, he explained, "they wouldn't look at me as having the same power if I did not use it." Mr.

Clark stated that the Internet gives him more opportunities to assist students. He asserted, “If a kid sees me on the computer, and its 11:30 at night, they can give me a quick instant message, and I can answer back to them.” Mr. Clark declared that he expects his students to blog on the Internet about specific mathematical content. He said that he requires them to blog because he tries “to use a medium that they’re already using and they’re already comfortable with.” Mr. Clark maintained that he wants his students to write about mathematical content on their blogs as opposed to writing a paper because he thinks papers are “kind of boring to these kids.”

Length of Time That Teachers Utilized Technology

Each of the three participants were observed teaching a 52 minute lesson on six different occasions. Three of these observations were announced to the participants ahead of time, and three were unannounced. The observations were videotaped and loaded onto a password protected computer. To establish the amount of time that the participants used technology, the videos were watched and different methods in which technology was utilized were identified. As a strategy was used, the length of time that it was employed was determined through the use of a stopwatch. In this section, the results of these recorded times is provided. The total amount of time that each strategy was utilized over the course of the six classroom observations is also presented.

Stacey Barber announced classroom observation one. The first observation of Ms. Barber occurred on August 25, 2010. This observation was announced ahead of time through email. During the lesson, Ms. Barber graphed absolute value inequalities. The following results were discovered regarding the amount of time that Ms. Barber used TI-Smartview, the Smartboard, and the Internet.

Ms. Barber neglected to use TI-Smartview during this lesson. Therefore, the amount of time that graphing calculator projectors were utilized during Ms. Barber's first lesson was 0 minutes 0 seconds.

Ms. Barber used the Smartboard in several different ways. She utilized the Smartboard as a screen to project class handouts for 32 minutes 58 seconds. Ms. Barber used the Smartboard to add onto the projected handouts using whiteboard pens for 13 minutes 44 seconds. The Smartboard was utilized to stimulate interactions between Ms. Barber and her students for 16 minutes 42 seconds. Ms. Barber asked questions directly on the Smartboard while teaching new content for 7 minutes 1 second. The Smartboard was used to review previously learned material for 18 minutes 38 seconds. Ms. Barber employed the Smartboard as a screen to project the student textbook for 16 minutes 52 seconds. Students also wrote their answers on the Smartboard for 5 minutes 21 seconds.

Ms. Barber only used the Internet for one purpose during this lesson. This purpose consisted of accessing the online version of the student textbook for 16 minutes 52 seconds. The Internet was not utilized for any other reason during this lesson.

Stacey Barber unannounced classroom observation two. The second observation of Ms. Barber occurred on August 31, 2010. This observation was unannounced. Therefore, Ms. Barber was unaware that she was going to be observed on this day. During the lesson, Ms. Barber focused on linear programming. The following results were discovered regarding the amount of time that Ms. Barber used TI-Smartview, the Smartboard, and the Internet.

Ms. Barber used TI-Smartview as an instructional device in several different ways. TI-Smartview was utilized to model the steps for solving problems to the entire class for 5 minutes 26 seconds. Ms. Barber used TI-Smartview as a visual representation for 2 minutes 26 seconds. TI-Smartview was employed as an alternative method of solving a problem for 6 minutes 55 seconds. Ms. Barber also utilized TI-Smartview to stimulate class discussion for 7 minutes 31 seconds.

The Smartboard was used in several distinctive ways during the second classroom observation. Ms. Barber employed the Smartboard as a screen to project class handouts for 30 minutes 40 seconds. She utilized the Smartboard to add onto the projected handouts using whiteboard pens for 20 minutes 5 seconds. Ms. Barber answered the students' questions on the Smartboard for 9 minutes 26 seconds. The Smartboard was utilized to stimulate interactions between Ms. Barber and her students for 33 minutes 56 seconds. She also used the Smartboard to provide visual representations for 14 minutes 5 seconds.

Ms. Barber neglected to use the Internet during this lesson. Therefore, the amount of time the Internet was utilized during Ms. Barber's second lesson was 0 minutes 0 seconds.

Stacey Barber announced classroom observation three. The third observation of Ms. Barber occurred on September 10, 2010. This observation was announced ahead of time through email. During the lesson, Ms. Barber focused on matrix operations, and students worked on problems independently at their desks. The following results were discovered regarding the amount of time that Ms. Barber used TI-Smartview, the Smartboard, and the Internet.

Ms. Barber neglected to use TI-Smartview during this lesson. Therefore, the amount of time that graphing calculator projectors were utilized during Ms. Barber's third lesson was 0 minutes 0 seconds.

Ms. Barber used the Smartboard in several different ways. She wrote the correct answers to the homework questions for 4 minutes 30 seconds. The Smartboard was utilized to stimulate interactions between Ms. Barber and her students for 5 minutes 30 seconds. Students also wrote their answers on the Smartboard for 1 minute 50 seconds.

Ms. Barber chose not to use the Internet during this lesson. Therefore, the amount of time the Internet was utilized during Ms. Barber's third lesson was 0 minutes 0 seconds.

Stacey Barber unannounced classroom observation four. The fourth observation of Ms. Barber occurred on September 14, 2010. This observation was unannounced. Therefore, Ms. Barber was unaware that she was going to be observed on this day. During the lesson, Ms. Barber reviewed the process for multiplying matrices and students worked on problems independently at their desks. The following results were discovered regarding the amount of time that Ms. Barber used TI-Smartview, the Smartboard, and the Internet.

Ms. Barber neglected to use TI-Smartview during this lesson. Therefore, the amount of time that graphing calculator projectors were utilized during Ms. Barber's fourth lesson was 0 minutes 0 seconds.

Ms. Barber used the Smartboard in several distinctive ways. She wrote the correct answers to the homework questions for 3 minutes 39 seconds. The Smartboard was used as a screen to project problems for students to complete for 32 minutes 48 seconds. Ms. Barber answered the students' questions on the Smartboard for 3 minutes 36 seconds. The Smartboard was also utilized as a screen to project a handout for 9 minutes 33 seconds.

Ms. Barber chose not to use the Internet during this lesson. Therefore, the amount of time the Internet was utilized during Ms. Barber's fourth lesson was 0 minutes 0 seconds.

Stacey Barber announced classroom observation five. The fifth observation of Ms. Barber occurred on September 21, 2010. This observation was announced ahead of time through email. During the lesson, Ms. Barber used matrices to solve systems of equations. The following results were discovered regarding the amount of time that Ms. Barber used TI-Smartview, the Smartboard, and the Internet.

Ms. Barber used TI-Smartview as an instructional device only once during this lesson. She utilized TI-Smartview to model the steps for solving problems to the entire class for 3 minutes 43 seconds. TI-Smartview was not employed for any other purpose.

Ms. Barber used the Smartboard in several different ways. The Smartboard was utilized as a screen to provide instructions for 0 minutes 56 seconds. She used the Smartboard as a screen to project handouts for 46 minutes 29 seconds. The Smartboard was employed to stimulate interactions between Ms. Barber and her students for 35 minutes 53 seconds. Ms. Barber provided the correct answers to the projected handouts for 11 minutes 41 seconds. Additional student questions were also answered on the Smartboard for 5 minutes 57 seconds.

Ms. Barber chose not to use the Internet during this lesson. Therefore, the amount of time the Internet was utilized during Ms. Barber's fifth lesson was 0 minutes 0 seconds.

Stacey Barber unannounced classroom observation six. The sixth observation of Ms. Barber occurred on September 28, 2010. This observation was unannounced. Therefore, Ms. Barber was unaware that she was going to be observed on this day. During the lesson, Ms. Barber allowed her students to work independently or in groups to solve problems related to vertex edge graphs. The following results were discovered regarding the amount of time that Ms. Barber used TI-Smartview, the Smartboard, and the Internet.

Ms. Barber neglected to use TI-Smartview during this lesson. Therefore, the amount of time that graphing calculator projectors were utilized during Ms. Barber's sixth lesson was 0 minutes 0 seconds.

Ms. Barber used the Smartboard in a couple of different ways. She wrote the correct answers to the homework questions for 10 minutes 34 seconds. Ms. Barber also utilized the Smartboard to set up a problem that was to be completed by her students at their desks. The time she took to set up this problem was 3 minutes 43 seconds.

Ms. Barber chose not to use the Internet during this lesson. Therefore, the amount of time the Internet was utilized during Ms. Barber's sixth lesson was 0 minutes 0 seconds.

Total amount of time Stacey Barber utilized technology. Three of the classroom observations were announced to Ms. Barber ahead of time, and three were unannounced. Table 1 represents the overall amount of time that graphing calculator projectors were utilized for instruction during the announced and unannounced observations. The total amount of time is also provided.

Table 1

Time that Ms. Barber Used Graphing Calculator Projectors for Instruction

Strategy	Announced	Unannounced	Total
1. Modeled steps for solving problems to entire class	3 min 43 sec	5 min 26 sec	9 min 9 sec
2. Provided visual representations	0 min 0 sec	2 min 26 sec	2 min 26 sec
3. Provided an alternative method for solving a problem	0 min 0 sec	6 min 55 sec	6 min 55 sec
4. Stimulated class discussion	0 min 0 sec	7 min 31 sec	7 min 31 sec

Table 2 shows the overall amount of time that interactive whiteboards were used as an interactive tool for instruction during the announced and unannounced observations. The total amount of time is also provided.

Table 2

Time that Ms. Barber Used Interactive Whiteboards as an Interactive Tool for Instruction

Strategy	Announced	Unannounced	Total
1. Added onto projected handouts using whiteboard pens	13 min 44 sec	20 min 5 sec	33 min 49 sec
2. Stimulated interaction between teacher and students	58 min 5 sec	33 min 56 sec	92 min 1 sec
3. Asked questions when teaching new content	7 min 1 sec	0 min 0 sec	7 min 1 sec
4. Reviewed material	18 min 38 sec	0 min 0 sec	18 min 38 sec
5. Wrote correct answers to homework	4 min 30 sec	14 min 13 sec	18 min 43 sec
6. Wrote correct answers to projected handouts	11 min 41 sec	0 min 0 sec	11 min 41 sec
7. Answered student questions	5 min 57 sec	9 min 26 sec	15 min 23 sec
8. Provided visual representations	0 min 0 sec	14 min 5 sec	14 min 5 sec
9. Set up a problem to be Completed by students	3 min 43 sec	0 min 0 sec	3 min 43 sec
10. Students wrote their answers	7 min 11 sec	0 min 0 sec	7 min 11 sec

In some instances, Ms. Barber used an interactive whiteboard as a screen rather than an interactive device. Table 3 gives the overall amount of time that interactive whiteboards were used as a screen for instruction during the announced and unannounced observations. The total amount of time is also provided.

Table 3

Time that Ms. Barber Used Interactive Whiteboards as a Screen for Instruction

Strategy	Announced	Unannounced	Total
1. Used as a screen to project handouts	79 min 27 sec	30 min 40 sec	110 min 7 sec
2. Used as a screen to project the student textbook	16 min 52 sec	0 min 0 sec	16 min 52 sec
3. Used as a screen to provide instructions	0 min 56 sec	0 min 0 sec	0 min 56 sec
4. Used as a screen to project problems for students to complete	32 min 48 sec	0 min 0 sec	32 min 48 sec

Accessing the student textbook was the only instance in which Ms. Barber used the Internet during the six classroom observations. Ms. Barber accessed the student textbook for 16 minutes 52 seconds during an announced observation. She did to use the Internet during any unannounced observation. Therefore, the total amount of time that Ms. Barber accessed the online version of the student textbook was 16 minutes 52 seconds.

James Bryant announced classroom observation one. The first observation of Mr. Bryant occurred on August 25, 2010. This observation was announced ahead of time through email. During the lesson, Mr. Bryant graphed systems of inequalities. The following results were discovered regarding the amount of time that Mr. Bryant used TI-Smartview, the Smartboard, and the Internet.

Mr. Bryant neglected to use TI-Smartview during this lesson. Therefore, the amount of time that graphing calculator projectors were utilized during Mr. Bryant's first lesson was 0 minutes 0 seconds.

Mr. Bryant used the Smartboard in several different ways. The Smartboard was utilized to give warm-up questions for 11 minutes 17 seconds. Mr. Bryant used the Smartboard as a screen to project previously prepared notes for 17 minutes 25 seconds. He added onto previously prepared notes using whiteboard pens for 8 minutes 46 seconds. The Smartboard was employed to stimulate interactions between Mr. Bryant and his students for 21 minutes 47 seconds. Mr. Bryant used the Smartboard to stimulate interactions between two or more students for 9 minutes 24 seconds. The Smartboard was utilized to ask questions to introduce a new topic for 5 minutes 26 seconds. Mr. Bryant asked questions directly on the Smartboard while teaching new content for 17 minutes 17 seconds. Student questions were answered on the Smartboard for 6 minutes 3 seconds. Students also wrote their answers on the Smartboard for 4 minutes 4 seconds.

Mr. Bryant chose not to use the Internet during this lesson. Therefore, the amount of time the Internet was utilized during Mr. Bryant's first lesson was 0 minutes 0 seconds.

James Bryant unannounced classroom observation two. The second observation of Mr. Bryant occurred on August 31, 2010. This observation was unannounced. Therefore, Mr. Bryant was unaware that he was going to be observed on this day. During the lesson, Mr. Bryant focused on linear programming. Students worked independently or in groups to answer word problems related to linear programming. The following results were discovered regarding the amount of time that Mr. Bryant used TI-Smartview, the Smartboard, and the Internet.

Mr. Bryant chose not to use TI-Smartview during this lesson. Therefore, the amount of time that graphing calculator projectors were utilized during Mr. Bryant's second lesson was 0 minutes 0 seconds.

Mr. Bryant used the Smartboard in several distinctive ways. The Smartboard was utilized to give warm-up questions for 7 minutes 29 seconds. Mr. Bryant reviewed previously learned material for 3 minutes 37 seconds. The Smartboard was used to provide visual representations for 2 minutes 46 seconds. Mr. Bryant also utilized the Smartboard to segue into a new topic for 1 minute 48 seconds.

Mr. Bryant chose not to use the Internet during this lesson. Therefore, the amount of time the Internet was utilized during Mr. Bryant's second lesson was 0 minutes 0 seconds.

James Bryant announced classroom observation three. The third observation of Mr. Bryant occurred on September 8, 2010. This observation was announced ahead of time through email. During the lesson, Mr. Bryant used matrix operations to solve matrix equations. The following results were discovered regarding the amount of time that Mr. Bryant used TI-Smartview, the Smartboard, and the Internet.

Mr. Bryant used TI-Smartview as an instructional device for only one purpose during this lesson. This purpose was to randomly select students for an activity. Mr.

Bryant employed TI-Smartview to randomly select students for 2 minutes 40 seconds. TI-Smartview was not utilized for any other reason.

Mr. Bryant used the Smartboard in several different ways. The Smartboard was utilized to give warm-up questions for 6 minutes 31 seconds. Correct answers to the warm-up questions were written on the Smartboard for 7 minutes 24 seconds. The Smartboard was employed to stimulate interactions between Mr. Bryant and his students for 24 minutes 40 seconds. Mr. Bryant utilized the Smartboard to introduce a new topic for 4 minutes 20 seconds. The Smartboard was used as a screen to give an assignment for 6 minutes 31 seconds. Class notes were written on a blank screen of the Smartboard for 2 minutes 50 seconds. Mr. Bryant utilized the Smartboard as a screen to project previously prepared notes for 7 minutes 12 seconds. The Smartboard was used to add onto previously prepared notes using whiteboard pens for 5 minutes 38 seconds. Mr. Bryant employed the Smartboard to summarize the lesson for 3 minutes 14 seconds. Students also wrote their answers on the Smartboard for 1 minute 58 seconds.

Mr. Bryant chose not to use the Internet during this lesson. Therefore, the amount of time the Internet was utilized during Mr. Bryant's third lesson was 0 minutes 0 seconds.

James Bryant unannounced classroom observation four. The fourth observation of Mr. Bryant occurred on September 14, 2010. This observation was unannounced. Therefore, Mr. Bryant was unaware that he was going to be observed on this day. During the lesson, Mr. Bryant used Cramer's Rule to solve systems of equations. The following results were discovered regarding the amount of time that Mr. Bryant used TI-Smartview, the Smartboard, and the Internet.

Mr. Bryant chose not to use TI-Smartview during this lesson. Therefore, the amount of time that graphing calculator projectors were utilized during Mr. Bryant's fourth lesson was 0 minutes 0 seconds.

Mr. Bryant used the Smartboard in several distinctive ways. The Smartboard was utilized to give warm-up questions for 19 minutes 40 seconds. Correct answers to the warm-up questions were written on the Smartboard for 3 minutes 52 seconds. The Smartboard was used to stimulate interactions between Mr. Bryant and his students for 16 minutes 22 seconds. Mr. Bryant utilized the Smartboard as a screen to project previously prepared notes for 15 minute 33 seconds. The Smartboard was used to add onto previously prepared notes using whiteboard pens for 5 minutes 36 seconds. Mr. Bryant employed the Smartboard as a screen to project problems for students to solve for 15 minutes 46 seconds. Students wrote their answers on the Smartboard for 6 minutes 8 seconds. The Smartboard was also used as a screen to give an assignment for 1 minute 0 seconds.

Mr. Bryant chose not to use the Internet during this lesson. Therefore, the amount of time the Internet was utilized during Mr. Bryant's fourth lesson was 0 minutes 0 seconds.

James Bryant announced classroom observation five. The fifth observation of Mr. Bryant occurred on September 21, 2010. This observation was announced ahead of time through email. During the lesson, Mr. Bryant used matrices to solve systems of equations. The following results were discovered regarding the amount of time that Mr. Bryant used TI-Smartview, the Smartboard, and the Internet.

Mr. Bryant chose not to use TI-Smartview during this lesson. Therefore, the amount of time that graphing calculator projectors were utilized during Mr. Bryant's fifth lesson was 0 minutes 0 seconds.

Mr. Bryant used the Smartboard in several different ways. The Smartboard was utilized to give warm-up questions for 17 minutes 46 seconds. Correct answers to the warm-up questions were written on the Smartboard for 9 minutes 44 seconds. The Smartboard was used to stimulate interactions between Mr. Bryant and his students for 22 minutes 29 seconds. He utilized the Smartboard as a screen to project previously prepared notes for 13 minutes 35 seconds. The Smartboard was used to add onto previously prepared notes using whiteboard pens for 3 minutes 11 seconds. Mr. Bryant employed the Smartboard as a screen to project problems for students to solve for 12 minutes 32 seconds. He used the Smartboard to summarize the lesson for 0 minutes 53 seconds. Mr. Bryant also used the Smartboard as a screen to give an assignment for 7 minute 14 seconds.

Mr. Bryant chose not to use the Internet during this lesson. Therefore, the amount of time the Internet was utilized during Mr. Bryant's fifth lesson was 0 minutes 0 seconds.

James Bryant unannounced classroom observation six. The sixth observation of Mr. Bryant occurred on September 30, 2010. This observation was unannounced. Therefore, Mr. Bryant was unaware that he was going to be observed on this day. During the lesson, Mr. Bryant allowed his students to work independently or in groups to solve problems related to vertex edge graphs. The following results were discovered regarding the amount of time that Mr. Bryant used TI-Smartview, the Smartboard, and the Internet.

Mr. Bryant chose not to use TI-Smartview during this lesson. Therefore, the amount of time that graphing calculator projectors were utilized during Mr. Bryant's sixth lesson was 0 minutes 0 seconds.

Mr. Bryant used the Smartboard in three distinct ways. The Smartboard was utilized to give warm-up questions for 6 minutes 41 seconds. Mr. Bryant used the Smartboard as a screen to provide instructions for 0 minutes 42 seconds. The Smartboard was also utilized as a screen to give an assignment for 17 minutes 48 seconds.

Mr. Bryant chose not to use the Internet during this lesson. Therefore, the amount of time the Internet was utilized during Mr. Bryant's sixth lesson was 0 minutes 0 seconds.

Total amount of time James Bryant utilized technology. Mr. Bryant only used a graphing calculator projector once during the six classroom observations. The one instance that a graphing calculator projector was utilized was to randomly select students to write their answers on the board. Mr. Bryant randomly selected students for 2 minutes 40 seconds during an announced observation. He chose not to use a graphing calculator projector during every unannounced observation. Therefore, the total amount of time that Mr. Bryant randomly selected students to write their answers on the board was 2 minutes 40 seconds.

In some instances, Mr. Bryant used an interactive whiteboard as a screen rather than an interactive device. Table 4 represents the overall amount of time that interactive whiteboards were used as a screen for instruction during the announced and unannounced observations. The total amount of time is also provided.

Table 4

Time that Mr. Bryant Used Interactive Whiteboards as a Screen for Instruction

Strategy	Announced	Unannounced	Total
1. Used as a screen to project previously prepared notes	38 min 12 sec	15 min 33 sec	53 min 45 sec
2. Used as a screen to give an assignment	13 min 45 sec	18 min 48 sec	33 min 33 sec
3. Used as a screen to project problems for students to solve	12 min 32 sec	15 min 46 sec	28 min 28 sec
4. Used as a screen to provide instructions	0 min 0 sec	0 min 42 sec	0 min 42 sec

Not only did Mr. Bryant utilize interactive whiteboards as a screen, but he also employed them as an interactive device. Table 5 shows the overall amount of time that interactive whiteboards were used as an interactive tool for instruction during the announced and unannounced observations. The total amount of time is also provided.

Table 5

Time that Mr. Bryant Used Interactive Whiteboards in an Interactive Tool for Instruction

Strategy	Announced	Unannounced	Total
1. Provided warm-up questions	35 min 34 sec	33 min 50 sec	69 min 24 sec
2. Wrote answers to warm-up	17 min 8 sec	3 min 52 sec	21 min 0 sec
3. Added onto previously prepared notes using whiteboard pens	17 min 35 sec	5 min 36 sec	23 min 11 sec
4. Stimulated interaction between teacher and students	68 min 56 sec	16 min 22 sec	85 min 18 sec
5. Stimulated interaction between two or more students	9 min 24 sec	0 min 0 sec	9 min 24 sec
6. Asked questions to introduce new topics	9 min 46 sec	0 min 0 sec	9 min 46 sec
7. Asked questions when teaching new content	17 min 17 sec	0 min 0 sec	17 min 17 sec
8. Answered student questions	6 min 3 sec	0 min 0 sec	6 min 3 sec
9. Wrote notes on a blank screen	2 min 50 sec	0 min 0 sec	2 min 50 sec
10. Summarized the lesson	4 min 7 sec	0 min 0 sec	4 min 7 sec
11. Reviewed material	0 min 0 sec	3 min 37 sec	3 min 37 sec
12. Provided visual representations	0 min 0 sec	2 min 46 sec	2 min 46 sec
13. Segued into a new topic	0 min 0 sec	1 min 48 sec	1 min 48 sec
14. Students wrote their answers	6 min 2 sec	6 min 8 sec	12 min 10 sec

Mr. Bryant chose not to use the Internet during the six classroom observations. Therefore, the total amount of time that the Internet was employed was 0 minutes 0 seconds.

Peter Clark announced classroom observation one. The first observation of Mr. Clark occurred on August 24, 2010. This observation was announced ahead of time through email. During the lesson, Mr. Clark graphed systems of inequalities. The following results were discovered regarding the amount of time that Mr. Clark used a graphing calculator panel, the television or overhead projector, and the Internet.

Mr. Clark used a graphing calculator panel as an instructional device only once during this lesson. A graphing calculator panel was utilized to provide visual representations for 6 minutes 59 seconds. Mr. Clark did not employ a graphing calculator panel for any other purpose.

The television and overhead projector were used in several different ways. Using the overhead projector, Mr. Clark projected handouts onto a screen for 31 minutes 58 seconds. The correct answers to the projected handouts were written on the overhead projector for 21 minutes 2 seconds. Internet videos were projected onto a television screen for 3 minutes 41 seconds. Mr. Clark reviewed previously prepared notes by projecting them onto a television screen for 4 minutes 12 seconds. An erasable pen was also used on a television screen to add onto previously prepared notes for 2 minutes 1 second.

Mr. Clark only used the Internet for one purpose during this lesson. This purpose consisted of accessing online videos for 3 minutes 41 seconds. The Internet was not utilized for any other reason during this lesson.

Peter Clark unannounced classroom observation two. The second observation of Mr. Clark occurred on September 2, 2010. This observation was unannounced. Therefore, Mr. Clark was unaware that he was going to be observed on this day. During the lesson, Mr. Clark transformed absolute value functions and graphed systems of inequalities. The following results were discovered regarding the amount of time that Mr. Clark used a graphing calculator panel, the television or overhead projector, and the Internet.

Mr. Clark used a graphing calculator panel as an instructional device in several different ways during this lesson. A graphing calculator panel was utilized to provide visual representations for 7 minutes 33 seconds. Mr. Clark employed the panel to model steps for solving problems for 8 minutes 0 seconds. A graphing calculator panel was used to stimulate class discussion for 5 minutes 49 seconds. Mr. Clark also used the panel for 4 minutes 39 seconds to show common mistakes made when using graphing calculators.

The television and overhead projector were utilized in several distinctive ways. Using the overhead projector, Mr. Clark projected handouts onto a screen for 9 minutes 28 seconds. The correct answers to the projected handouts were written on the overhead projector for 15 minutes 49 seconds. Mr. Clark reviewed previously prepared notes by projecting them onto a television screen for 17 minutes 4 seconds. He projected previously prepared notes onto a television screen to teach new content for 0 minutes 38 seconds. Mr. Clark used an erasable pen on a television screen to add onto previously prepared notes for 11 minutes 18 seconds. He projected his blog onto a television screen for 0 minutes 41 seconds. Mr. Clark used the television to stimulate interactions with his students for 0 minutes 10 seconds. Student blogs were also projected onto a television screen for 0 minutes 7 seconds.

Mr. Clark used the Internet for a couple of purposes during this lesson. The Internet was utilized to access Mr. Clark's blog for 0 minutes 41 seconds. Mr. Clark also employed the Internet to view a student's blog for 0 minutes 7 seconds.

Peter Clark announced classroom observation three. The third observation of Mr. Clark occurred on September 10, 2010. This observation was announced ahead of time through email. During the lesson, Mr. Clark allowed his students to catch up on their work in the computer lab. The following results were discovered regarding the amount of time that Mr. Clark used a graphing calculator panel, the television or overhead projector, and the Internet.

Mr. Clark did not use a graphing calculator panel during this lesson. Therefore, the amount of time that graphing calculator projectors were utilized during Mr. Clark's third lesson was 0 minutes 0 seconds.

Mr. Clark also chose not to use the television or overhead projector during this lesson. Therefore, the amount of time that interactive whiteboards were utilized during Mr. Clark's third lesson was 0 minutes 0 seconds.

Mr. Clark used the Internet in several ways during this class period. Students utilized the Internet to access Mr. Clark's webpage for 2 minutes 54 seconds. Mr. Clark's students completed an online survey for 0 minutes 53 seconds. For the remainder of the period, Mr. Clark's students had the option of completing one of four tasks on the Internet. These tasks included taking an online exam, completing an assignment, submitting an assignment, or working on a blog. Mr. Clark's students were given 41 minutes 40 seconds to work on these assignments.

Peter Clark unannounced classroom observation four. The fourth observation of Mr. Clark occurred on September 15, 2010. This observation was unannounced. Therefore, Mr. Clark was unaware that he was going to be observed on this day. During the lesson, Mr. Clark used Cramer's Rule to solve systems of equations. The following results were discovered regarding the amount of time that Mr. Clark used a graphing calculator panel, the television or overhead projector, and the Internet.

Mr. Clark used a graphing calculator panel as an instructional device in several different ways during this lesson. A graphing calculator panel was utilized to provide visual representations for 1 minute 55 seconds. Mr. Clark employed the panel to model steps for solving problems for 13 minutes 24 seconds. A graphing calculator panel was also used to make predictions for 1 minute 17 seconds.

The television and overhead projector were utilized in two distinct ways. Using the overhead projector, Mr. Clark projected handouts onto a screen for 7 minutes 18 seconds. Internet videos were also projected onto a television screen for 1 minute 42 seconds.

Mr. Clark only used the Internet for one purpose during this lesson. This purpose consisted of accessing online videos for 1 minute 42 seconds. The Internet was not utilized for any other reason during this lesson.

Peter Clark announced classroom observation five. The fifth observation of Mr. Clark occurred on September 24, 2010. This observation was announced ahead of time through email. During the lesson, Mr. Clark reviewed the rules that are required to find an equation of a circle. The following results were discovered regarding the amount of time that Mr. Clark used a graphing calculator panel, the television or overhead projector, and the Internet.

Mr. Clark used a graphing calculator panel as an instructional device in several different ways during this lesson. A graphing calculator panel was utilized to provide visual representations for 6 minutes 23 seconds. Mr. Clark employed the panel to model steps for solving problems for 8 minutes 39 seconds. A graphing calculator panel was also used to stimulate class discussion for 9 minute 13 seconds.

The television was used in three separate ways. Mr. Clark reviewed previously prepared notes by projecting them onto a television screen for 25 minutes 36 seconds. He projected previously prepared notes onto a television screen to teach new content for 2 minutes 34 seconds. An erasable pen was also used on a television screen to add onto previously prepared notes for 3 minutes 4 seconds.

Mr. Clark chose not to use the Internet during this lesson. Therefore, the amount of time the Internet was utilized during Mr. Clark's fifth lesson was 0 minutes 0 seconds.

Peter Clark unannounced classroom observation six. The sixth observation of Mr. Clark occurred on September 28, 2010. This observation was unannounced. Therefore, Mr. Clark was unaware that he was going to be observed on this day. During the lesson, Mr. Clark provided an introduction to solving equations of circles. The following results were discovered regarding the amount of time that Mr. Clark used a graphing calculator panel, the television or overhead projector, and the Internet.

Mr. Clark used a graphing calculator panel as an instructional device in two distinct ways during this lesson. A graphing calculator panel was utilized to provide visual representations for 0 minutes 56 seconds. Mr. Clark also employed the panel to model steps for solving problems for 1 minute 24 seconds.

The television and overhead projector were utilized in three distinct ways. Using the overhead projector, Mr. Clark wrote the correct answers to a handout for 5 minutes 6 seconds. He projected previously prepared notes onto a television screen to teach new content for 9 minutes 57 seconds. An erasable pen was also used on a television screen to add onto previously prepared notes for 3 minutes 40 seconds.

Mr. Clark chose not to use the Internet during this lesson. Therefore, the amount of time the Internet was utilized during Mr. Clark's sixth lesson was 0 minutes 0 seconds.

Total amount of time Peter Clark utilized technology. Three of the classroom observations were announced to Mr. Clark ahead of time, and three were unannounced. Table 6 represents the overall amount of time that graphing calculator projectors were utilized for instruction during the announced and unannounced observations. The total amount of time is also provided.

Table 6

Time that Mr. Clark Used Graphing Calculator Projectors for Instruction

Strategy	Announced	Unannounced	Total
1. Modeled steps for solving problems to entire class	8 min 39 sec	22 min 48 sec	31 min 27 sec
2. Provided visual representations	13 min 22 sec	10 min 24 sec	23 min 46 sec
3. Showed common mistakes	0 min 0 sec	4 min 39 sec	4 min 39 sec
4. Stimulated class discussion	9 min 13 sec	5 min 49 sec	15 min 2 sec
5. Made predictions	0 min 0 sec	1 min 17 sec	1 min 17 sec

Table 7 shows the overall amount of time that interactive whiteboards were used as an interactive tool for instruction during the announced and unannounced observations. The total amount of time is also provided.

Table 7

Time that Mr. Clark Used Interactive Whiteboards as an Interactive Tool for Instruction

Strategy	Announced	Unannounced	Total
1. Wrote correct answers to projected handouts	21 min 2 sec	5 min 6 sec	26 min 8 sec
2. Added onto previously prepared notes using an erasable pen	5 min 5 sec	14 min 58 sec	20 min 3 sec
3. Stimulated interaction between teacher and students	0 min 0 sec	0 min 10 sec	0 min 10 sec

In some instances, Mr. Clark used an interactive whiteboard as a screen rather than an interactive device. Table 8 shows the overall amount of time that interactive whiteboards were used as a screen for instruction during the announced and unannounced observations. The total amount of time is also provided.

Table 8

Time that Mr. Clark Used Interactive Whiteboards as a Screen for Instruction

Strategy	Announced	Unannounced	Total
1. Used as a screen to project class handouts	31 min 58 sec	16 min 46 sec	48 min 44 sec
2. Used as a screen to project Internet videos	3 min 41 sec	1 min 42 sec	5 min 23 sec
3. Used as a screen to review previously prepared notes	29 min 48 sec	17 min 4 sec	46 min 52 sec
4. Used as a screen to project previously prepared notes to teach new content	2 min 34 sec	10 min 35 sec	13 min 9 sec
5. Used as a screen to project teacher’s blog	0 min 0 sec	0 min 41 sec	0 min 41 sec
6. Used as a screen to project student blogs	0 min 0 sec	0 min 7 sec	0 min 7 sec

Table 9 expresses the overall amount of time that the Internet was used for instruction during the announced and unannounced observations. The total amount of time is also provided.

Table 9

Time that Mr. Clark Used the Internet for Instruction

Strategy	Announced	Unannounced	Total
1. Accessed Internet videos	3 min 41 sec	1 min 42 sec	5 min 23 sec
2. Viewed teacher's blog	0 min 0 sec	0 min 41 sec	0 min 41 sec
3. Viewed student blogs	0 min 0 sec	0 min 7 sec	0 min 7 sec
4. Students accessed teacher webpage	2 min 54 sec	0 min 0 sec	2 min 54 sec
5. Students completed online survey	0 min 53 sec	0 min 0 sec	0 min 53 sec
6. Students took online exams	41 min 40 sec	0 min 0 sec	41 min 40 sec
7. Students worked on blogs	41 min 40 sec	0 min 0	41 min 40 sec
8. Students completed online assignments	41 min 40 sec	0 min 0 sec	41 min 40 sec
9. Students submitted online assignments	41 min 40 sec	0 min 0 sec	41 min 40 sec

Research Question Two

The second research question addressed the impact of attitudes on the amount of time that technology is used for instruction. To answer this question, connections were searched for that related to the participants' attitudes and the amount of time that was spent employing technology. This procedure was done independently for each participant. Once this process was completed, common themes were searched for between the three participants regarding each type of technology. When themes were discovered, a peer review was performed by asking one high school mathematics teacher and two college professors to validate that the conclusions were satisfactory. Once an agreement was reached among the group, the credibility of the findings was enhanced.

Common Themes

When analyzing the research, specific themes were discovered for each participant. In some cases, these themes were shared between two of the three teachers. However, themes revealed for one participant or shared by two of the three teachers are not discussed in this section. In this section, only the themes that were common among all three participants are described.

Theme one. The first theme that was observed was that when teachers have positive attitudes toward graphing calculator projectors they are unlikely to use them with a small group of students while the remainder of the class completes a task independently. This theme was observed in all three participants. For instance, when Ms. Barber completed her pre-observational survey, she agreed that graphing calculator projectors provide students with visual representations that are necessary for student learning, increase student enjoyment in mathematics, encourage interaction between the student and the teacher, and can easily be employed during instruction. Also, she disagreed that they promote laziness in students and strongly disagreed that they require substantial preparation time for use. In her first stimulated recall interview (Stacey

Barber, personal communication, September 23, 2010), Ms. Barber stated, “I just think it’s a good visual for students on how to use their calculator.” She also claimed that graphing calculator projectors are a helpful modeling device by saying, “I like the Smartview because students can physically see me pressing the buttons and see the list of key presses.”

In spite of Ms. Barber’s positive attitudes toward graphing calculator projectors, she declined to use them with a small group of students while the rest of the class completed assignments on their own. In the third classroom observation, Ms. Barber’s students worked independently on problems that related to matrix operations. During this lesson, Ms. Barber used a graphing calculator projector for 0 minutes 0 seconds. In the fourth classroom observation, Ms. Barber’s students completed problems on their own which were associated with multiplying matrices. Again, Ms. Barber utilized a graphing calculator projector for 0 minutes 0 seconds. During the sixth classroom observation, Ms. Barber’s students solved problems related to vertex edge graphs independently or in groups. Once more, a graphing calculator projector was employed for 0 minutes 0 seconds.

Mr. Bryant also displayed positive attitudes regarding graphing calculator projectors. In his pre-observational survey, Mr. Bryant strongly agreed that graphing calculator projectors increase student motivation and enjoyment in mathematics, allow students to gain a deeper understanding of course content, and can easily be employed during instruction. He agreed that graphing calculator projectors provide students with visual representations that are necessary for student learning and encourage interaction between the student and the teacher. Mr. Bryant disagreed that graphing calculator projectors promote laziness in students. In his second stimulated recall interview (James Bryant, personal communication, October 5, 2010), Mr. Bryant claimed that TI-Smartview is helpful when modeling problems because “you can show every single step; you know every button that you pressed.” He also claimed that TI-Smartview is “so much nicer than other programs because you can make graphs larger.”

Although Mr. Bryant revealed positive attitudes related to graphing calculator projectors, he chose not to use them with a small group of students while the remainder of the class worked on tasks independently. During the second classroom observation, Mr. Bryant’s students had the option of working on their own or in groups when answering word problems associated with linear programming. In this lesson, Mr. Bryant used a graphing calculator projector for 0 minutes 0 seconds. During the sixth classroom observation, Mr. Bryant’s students solved problems related to vertex edge graphs independently or in groups. Again, a graphing calculator projector was utilized for 0 minutes 0 seconds.

Mr. Clark also expressed positive attitudes regarding graphing calculator projectors. In his pre-observational survey, Mr. Clark strongly agreed that graphing calculator projectors provide students with visual representations that are necessary for student learning, increase student motivation and enjoyment in mathematics, and can easily be employed during instruction. Mr. Clark agreed that graphing calculator projectors encourage interaction between the student and the teacher and allow students to gain a deeper understanding of course content. He disagreed that graphing calculator projectors promote laziness in students and strongly disagreed that they require substantial preparation time for use. In his first stimulated recall interview (Peter Clark, personal communication, September 19, 2010), Mr. Clark mentioned that graphing calculator projectors support what students already know, expand the universe of students, and teach students "how to use technology correctly." In the second stimulated recall interview (Peter Clark, personal communication, October 3, 2010), Mr. Clark explained that graphing calculator projectors enable him to "connect to students," present information in a better way, and offer shortcuts to solving problems.

In spite of his positive attitudes toward graphing calculator projectors, Mr. Clark chose not to use them with a small group of students while the remainder of the class worked on an assignment independently. In the third classroom observation, Mr. Clark allowed his students to catch up on assignments in the computer lab. Mr. Clark's students worked on their own when completing these tasks. Nevertheless, Mr. Clark neglected to employ a graphing calculator projector. Therefore, the amount of time that a graphing calculator projector was utilized during this lesson was 0 minutes 0 seconds.

Theme two. The second theme that was observed was that when teachers have positive attitudes regarding the benefits of interactive whiteboards on student learning, students are likely to use them in a limited capacity. This theme was observed in all three participants. For example, when Ms. Barber finished her pre-observational survey, she strongly agreed that interactive whiteboards provide students with visual representations that are necessary for student learning and are helpful when teaching students with different learning styles. Ms. Barber also agreed that interactive whiteboards increase student motivation and enjoyment in mathematics. In her first stimulated recall interview (Stacey Barber, personal communication, September 23, 2010), Ms. Barber stated that interactive whiteboards enhance student learning because they “minimize distractions” and allow students to establish a daily routine.

In spite of Ms. Barber’s attitudes regarding the benefits of interactive whiteboards on student learning, writing answers directly onto the board was the only manner in which students used the interactive device. During the first classroom observation, students wrote their answers to a handout related to absolute value inequalities on the interactive whiteboard for 5 minutes 21 seconds. In the third classroom observation, students wrote their answers to problems associated with matrix operations on the interactive whiteboard to problems associated with matrix operations for 1 minute 50 seconds. These were the only two lessons in which students wrote their answers on the board. The total amount of time that students wrote their answers on the interactive whiteboard was 7 minutes 11 seconds.

Mr. Bryant also showed positive attitudes toward the interactive whiteboard with regard to student learning. In his pre-observational survey, Mr. Bryant strongly agreed that interactive whiteboards provide students with visual representations that are necessary for student learning, increase student motivation and enjoyment in mathematics, are helpful when teaching students with different learning styles, and are helpful when teaching students who speak different languages. During his first stimulated recall interview (James Bryant, personal communication, September 10, 2010), Mr. Bryant claimed that interactive whiteboards allow him to quickly “bounce back and forth” between slides when students have questions about content taught earlier in the lesson.

Although Mr. Bryant displayed positive attitudes regarding the benefits of interactive whiteboards on student learning, writing answers directly onto the whiteboard was the only manner in which students employed this technological device. During the first classroom observation, students wrote their answers to a system of inequalities on the interactive whiteboard for 4 minutes 4 seconds. In the third classroom observation, students wrote their answers to matrix equations on the interactive whiteboard for 1 minute 58 seconds. During the fourth classroom observation, students wrote their answers to questions associated with Cramer's Rule on the interactive whiteboard for 6 minutes 8 seconds. These were the only three lessons that students wrote their answers on the interactive whiteboard. The total amount of time that students wrote answers on the interactive whiteboard was 12 minutes 10 seconds.

Mr. Clark also expressed positive attitudes regarding the impact of interactive whiteboards on student learning. In his pre-observational survey, Mr. Clark strongly agreed that interactive whiteboards provide students with visual representations that are necessary for student learning, increase student motivation in mathematics, are helpful when teaching students with different learning styles, and are helpful when teaching students who speak different languages. He agreed that interactive whiteboards increase student enjoyment in mathematics. In Mr. Clark's first stimulated recall interview (Peter Clark, personal communication, September 19, 2010), he explained that interactive whiteboards allow him to "build on a concept" and model the process for solving problems. During his second stimulated recall interview (Peter Clark, personal communication, October 3, 2010), Mr. Clark expressed that interactive whiteboards allow him to “fill in the gaps” for students who do not remember previously learned content and to show students how mathematics “fits into the world we live in.”

Despite Mr. Clark’s positive attitudes toward the impact of interactive whiteboards on student learning, students never came to the interactive whiteboard during the six classroom observations. Therefore, the total amount of time that students came to the interactive whiteboard was 0 minutes 0 seconds.

Theme three. The third theme that was discovered was that when teachers have positive attitudes toward interactive whiteboards, they are likely to use the whiteboard as a screen to project class notes and to add onto these notes using whiteboard pens. This theme was noticed in all three participants. For instance, Ms. Barber expressed additional positive attitudes towards interactive whiteboards besides those related to their benefits on student learning. When completing her pre-observational survey, Ms. Barber strongly agreed that interactive whiteboards allow teachers to enrich their lessons. She disagreed that interactive whiteboards are difficult to operate and require substantial preparation time to use. In her second stimulated recall interview (Stacey Barber, personal communication, September 30, 2010), Ms. Barber stated that projecting handouts or notes on the whiteboard allows her to “move at a faster pace.”

This study showed that having positive attitudes toward interactive whiteboards increased the likelihood of Ms. Barber using the whiteboard as a screen to project handouts and adding onto these handouts using whiteboard pens. During Ms. Barber’s second stimulated recall interview (Stacey Barber, personal communication, September 30, 2010), she claimed that these handouts serve as notes for her students. Ms. Barber stated that she gives handouts as notes because “a lot of kids have issues with organization and focusing" and these handouts prevent students from getting "stressed about writing everything down." Therefore, the notes that she projected functioned as the students' notes.

In the first classroom observation, Ms. Barber used the Smartboard as a screen to project a handout associated with graphing inequalities. During the lesson, Ms. Barber projected this handout for 32 minutes 58 seconds and added onto the handout for 13 minutes 44 seconds. In the second classroom observation, Ms. Barber used the Smartboard as a screen to project a handout related to linear programming. During the lesson, Ms. Barber projected the handout for 30 minutes 40 seconds and added onto the handout for 20 minutes 5 seconds. In the fifth classroom observation, Ms. Barber used the Smartboard as a screen to project a handout pertaining to solving systems of equations using matrices. During this lesson, Ms. Barber projected the handout for 46 minutes 29 seconds, but she did not add any additional information onto the handout.

These three lessons were the only instances where Ms. Barber used the Smartboard as a screen to project handouts and added onto these handouts using whiteboard pens. Therefore, the total amount of time that Ms. Barber projected handouts was 1 hour 50 minutes 7 seconds, and she added onto these handouts for 33 minutes 49 seconds.

Mr. Bryant also displayed positive attitudes toward interactive whiteboards. In addition to the attitudes mentioned regarding the benefits of interactive whiteboards on student learning, Mr. Bryant revealed other positive attitudes. With regard to his pre-observational survey, Mr. Bryant strongly agreed that interactive whiteboards allow teachers to enrich their lessons and disagreed that they are difficult to operate. In his first stimulated recall interview (James Bryant, personal communication, September 10, 2010), Mr. Bryant stated that interactive whiteboards are easy to manipulate and save. He also described his preference for interactive whiteboards over dry-erase boards because “the visuals on the Smartboard are much more powerful.”

This study showed that having positive attitudes toward interactive whiteboards improved the chances of Mr. Bryant using the Smartboard as a screen to project previously prepared class notes and adding onto these notes using whiteboards pens. In the first classroom observation, Mr. Bryant used the Smartboard as a screen to project notes related to graphing systems of inequalities. During this lesson, Mr. Bryant projected these notes for 17 minutes 25 seconds and added onto these notes for 8 minutes 46 seconds. In the third classroom observation, Mr. Bryant used the Smartboard as a screen to project notes associated with using matrix operations to solve matrix equations. During this lesson, Mr. Bryant projected these notes for 7 minutes 12 seconds and added onto these notes for 5 minutes 38 seconds. In the fourth classroom observation, Mr. Bryant used the Smartboard as a screen to project notes related to using Cramer’s Rule to solve systems of equations. During this lesson, Mr. Bryant projected these notes for 15 minutes 33 seconds and added onto these notes for 5 minutes 36 seconds. In the fifth classroom observation, Mr. Bryant used the Smartboard as a screen to project notes associated with using matrices to solve systems of equations. During this lesson, Mr. Bryant projected these notes for 13 minutes 35 seconds and added onto these notes for 3 minutes 11 seconds.

These four lessons were the only cases where Mr. Bryant used the Smartboard as a screen to project notes and added onto these notes using whiteboard pens. Therefore, the total amount of time that Mr. Bryant projected previously prepared notes was 53 minutes 45 seconds, and he added onto these notes for 23 minutes 11 seconds.

Mr. Clark also expressed positive attitudes toward interactive whiteboards. In addition to the attitudes mentioned regarding the benefits of interactive whiteboards on student learning, Mr. Clark revealed other positive attitudes. With regard to his pre-observational survey, Mr. Clark strongly agreed that interactive whiteboards allow teachers to enrich their lessons. He disagreed that interactive whiteboards are difficult to operate and require substantial preparation time for use. In his second stimulated recall interview (Peter Clark, personal communication, October 3, 2010), Mr. Clark mentioned that interactive whiteboards provide a means for deriving formulas that teach students "where rules come from."

This study showed that having positive attitudes toward interactive whiteboards improved the chances of Mr. Clark using the whiteboard as a screen to project previously prepared class notes and adding onto these notes using whiteboards pens. In the first classroom observation, Mr. Clark used the whiteboard as a screen to project previously prepared notes to review the process for graphing systems of inequalities. During this lesson, Mr. Clark reviewed these notes for 4 minutes 12 seconds and added onto these notes for 2 minutes 1 second. In the second classroom observation, Mr. Clark used the whiteboard as a screen to project previously prepared notes to review and teach new content related to transforming absolute value functions and graphing systems of inequalities. During this lesson, Mr. Clark reviewed these notes for 17 minutes 4 seconds, taught the new content for 0 minutes 38 seconds, and added onto these notes for 11 minutes 18 seconds. In the fifth classroom observation, Mr. Clark used the whiteboard as a screen to project previously prepared notes to review and teach new content related to finding equations of circles. During this lesson, Mr. Clark reviewed these notes for 25 minutes 36 seconds, taught new content for 2 minutes 34 seconds, and added onto these notes for 3 minutes 4 seconds. In the sixth classroom observation, Mr. Clark used the whiteboard as a screen to project previously prepared notes to introduce the process for solving equations of circles. During this lesson, Mr. Clark projected these notes to teach new content for 9 minutes 57 seconds and added onto them for 3 minutes 40 seconds.

These four lessons were the only instances where Mr. Clark used the whiteboard as a screen to project notes and added onto these notes using whiteboard pens. Therefore, the total amount of time that Mr. Clark reviewed by projecting previously prepared notes, taught new content by projecting previously prepared notes, and added onto the projected notes was 46 minutes 52 seconds, 13 minutes 9 seconds, and 20 minutes 3 seconds, respectively.

Theme four. The fourth theme that was noticed was that when teachers have positive attitudes regarding the benefits of the Internet on instruction they are likely to use it sparingly during their classes. This theme was observed in all three participants. For instance, when Ms. Barber completed her pre-observational survey, she agreed that the Internet enhances student critical thinking skills, increases student motivation in mathematics, and allows teachers to meet the individual needs of more students. Ms. Barber disagreed that it requires substantial preparation time to locate appropriate websites. Regarding her stimulated recall interviews, Ms. Barber did not reveal any additional attitudes because the Internet was not utilized during the lessons discussed in those interviews.

In spite of Ms. Barber's positive attitudes toward the Internet, she only used the Internet once during the six classroom observations. During the first classroom observation, Ms. Barber accessed the online version of the student textbook for 16 minutes 52 seconds. This was the only instance where Ms. Barber utilized the Internet during the observations.

Mr. Bryant also displayed positive attitudes toward the Internet. In his pre-observational survey, Mr. Bryant strongly agreed that the Internet is helpful when introducing a new topic and allows teachers to meet the individual needs of more students. He agreed that the Internet enhances student critical thinking skills, allows teachers to enrich their lessons, increases student motivation and enjoyment in mathematics, and allows students to gain a deeper understanding of course content. In his first stimulated recall interview (James Bryant, personal communication, September 10, 2010), Mr. Bryant mentioned that the Internet allows him to assist children because he can post his lessons online for students to view from home.

Although Mr. Bryant's showed positive attitudes toward the Internet, he did not use it during the six classroom observations. Therefore, the total amount of time that the Internet was employed was 0 minutes 0 seconds.

Mr. Clark also expressed positive attitudes toward the Internet. In his pre-observational survey, Mr. Clark strongly agreed that the Internet enhances student critical thinking skills, allows teachers to enrich their lessons, is helpful when introducing a new topic, increases student motivation and enjoyment in mathematics, allows students to gain a deeper understanding of course content, and allows teachers to meet the individual needs of more students. He strongly disagreed that the Internet requires substantial time to locate appropriate websites. In his first stimulated recall interview (Peter Clark, personal communication, September 19, 2010), Mr. Clark claimed that the Internet allows him to find videos to supplement the course, which creates more opportunities for students to understand the content. During his second stimulated recall interview (Peter Clark, personal communication, October 3, 2010), Mr. Clark stated that the Internet allows him to assist students outside of regular school hours and "to use a medium that they're already using and they're already comfortable with."

Despite Mr. Clark's positive attitudes toward the Internet, he only used the Internet in three ways during the six classroom observations: accessing Internet videos, viewing his blog, and viewing a student's blog. While Mr. Clark did utilize the Internet in more ways than Ms. Barber and Mr. Bryant, the two cases where a blog was accessed occurred during one observation, for less than one minute. In the second classroom observation, Mr. Clark accessed his own blog for 0 minutes 41 seconds and a student's blog for 0 minutes 7 seconds.

During two of the six classroom observations, Mr. Clark accessed Internet videos. In the first classroom observation, Mr. Clark showed a video on graphing systems of inequalities for 3 minutes 41 seconds. During the fourth classroom observation, Mr. Clark displayed a video on using Cramer's Rule to solve systems of equations for 1 minute 42 seconds. The total amount of time that videos were accessed through the Internet was 5 minutes 23 seconds.

Two Additional Themes

Theme five. An additional theme revealed in this study was that in some cases, common attitudes had a different impact on the way technology was used by the participants. For instance, from the pre-observational survey, all three participants agreed that graphing calculator projectors provide students with visual representations that are necessary for student learning. In spite of their agreement, the total amount of time that graphing calculator projectors were utilized to present visual representations varied from teacher to teacher. Ms. Barber gave visual representations for a total of 2 minutes 26 seconds, Mr. Bryant never used the graphing calculator projector to provide visual representations, and Mr. Clark offered visual representations for a total of 23 minutes 46 seconds.

In another case, the pre-observational survey revealed that all three participants strongly agreed that interactive whiteboards provide students with visual representations that are necessary for student learning. Again, the amount of time that interactive whiteboards were employed to present visual representations varied from individual to individual. Ms. Barber offered visual representations on the interactive whiteboard for a total of 14 minutes 5 seconds, Mr. Bryant gave visual representations for a total of 2 minutes 46 seconds, and Mr. Clark never used the interactive whiteboard to provide visual representations.

The third case where common attitudes impacted the participants differently involved the use of graphing calculator projectors as a modeling device. In Ms. Barber’s first stimulated recall interview (Stacey Barber, personal communication, September 23, 2010), she said that she likes using TI-Smartview to model problems because students can “physically see me pressing the buttons and see the list of key presses.” During the six classroom observations, Ms. Barber used a graphing calculator projector as a modeling device for a total of 9 minutes 9 seconds.

In Mr. Bryant’s second stimulated recall interview (James Bryant, personal communication, October 5, 2010), he claimed that TI-Smartview is valuable because he can show students “every single step; you know every button that you pressed.” Mr. Bryant also stated that modeling problems with TI-Smartview is helpful to students who utilize non-graphing calculators because “it looks similar enough to theirs.” In spite of these positive attitudes, Mr. Bryant never used a graphing calculator projector as a modeling device during the six classroom observations.

During Mr. Clark’s second stimulated recall interview (Peter Clark, personal communication, October 3, 2010), he mentioned that graphing calculator projectors are useful when modeling the process for employing graphing calculators properly. Mr. Clark claimed that he can correctly model the steps using a graphing calculator panel because he has a “concrete item” in his hand and he is “punching the same buttons” as his students. During the six classroom observations, Mr. Clark used a graphing calculator projector as a modeling device for a total of 31 minutes 27 seconds.

Theme six. This case study also revealed that more experienced teachers employ the Internet as an instructional device in a greater capacity than less experienced ones. For instance, Mr. Clark has 26 years of teaching experience, Mr. Bryant has 11 years of teaching experience, and Ms. Barber has 2 years of teaching experience. Mr. Clark used the Internet to access videos, view his blog, and examine student blogs. He also allowed his students to access his webpage, complete an online survey, take an online exam, work on their blogs, and finish online assignments. On the other hand, Mr. Bryant never used the Internet as an instructional device, and Ms. Barber only utilized the Internet to access the online version of the students' textbook.

It is important to note that, due to the small sample, it is unlikely that this theme can be transferred to other educational settings. A larger sample size of educators in the beginning, middle, and later stages of their careers would make this theme more transferable to other populations. Nevertheless, for this case study the more experienced teacher employed the Internet as an instructional device in a greater capacity than educators in the beginning and middle of their careers.

Research Question Three

During the stimulated recall interviews, the participants were asked questions to gain a deeper understanding as to why technology was employed in given situations. These stimulated recall sessions provided assistance in acquiring not only a more thorough awareness of the attitudes and beliefs of the participants, but also a better understanding of the causes of these viewpoints from the participants' perspectives. It is important to note that research was not conducted to confirm whether these beliefs actually led to specific attitudes towards technology. These findings merely serve as baseline data for why teachers hold certain viewpoints. I was unable to focus on every attitude of the participants. Therefore, only the causes of the participants' attitudes that were discussed during the stimulated recall interviews are emphasized.

Causes of Stacey Barber's attitudes toward graphing calculator projectors. In the first stimulated recall interview (Stacey Barber, personal communication, September 23, 2010), Ms. Barber mentioned her beliefs regarding two attitudes related to

TI-Smartview. Ms. Barber claimed that TI-Smartview is an effective modeling device because she observed that both she and her students were “solving the problems together.” Ms. Barber also maintained that TI-Smartview is successful as a visual representation of data because students often “make comments” with regard to the graphs being presented.

In the second stimulated recall interview (Stacey Barber, personal communication, September 30, 2010), Ms. Barber discussed her belief about one attitude related to TI-Smartview. Ms. Barber mentioned that using TI-Smartview herself led her to realize that the program loads slowly. In spite of the delay, Ms. Barber stated, “I wouldn’t ever choose not to use it because it takes too long to load.” In order to alleviate this issue, Ms. Barber “likes to open it at the beginning of the day and leave it open for the entire day.”

Causes of Stacey Barber’s attitudes toward interactive whiteboards. In the first stimulated recall interview (Stacey Barber, personal communication, September 23, 2010), Ms. Barber mentioned her beliefs behind two attitudes related to the Smartboard. Ms. Barber mentioned that distractions are minimized when she writes the correct answers on the Smartboard because “it’s up there and if they are not listening at the exact moment I say the answer, then they can see it and not have to disrupt and ask me to repeat it.” She also claimed that the Smartboard is more effective than the dry-erase board because, in her experience, dry-erase board “markers get dull.” Ms. Barber explained that with a Smartboard, “it’s nice to be able to go back to a problem,” but with a dry-erase board, “you would have already erased it.”

In the second stimulated recall interview (Stacey Barber, personal communication, September 30, 2010), Ms. Barber discussed her belief about one attitude related to the Smartboard. Ms. Barber maintained that classes move more rapidly when she projects handouts or notes on her Smartboard because she does not have to "waste class time" writing down the problems or notes. She noticed that she only has to "fill in the work" rather than rewriting everything, which enables her to cover more content during her classes.

Causes of Stacey Barber's attitudes toward the Internet. The stimulated recall interviews focused on two classroom observations. In neither of these lessons was the Internet utilized. Therefore, Ms. Barber did not discuss any additional attitudes regarding the Internet, nor did she mention how she believes her attitudes associated with the Internet were developed.

Causes of James Bryant's attitudes toward graphing calculator projectors. In the first stimulated recall interview (James Bryant, personal communication, September 10, 2010), Mr. Bryant mentioned his belief behind one attitude related to TI-Smartview. Mr. Bryant stated that students are more alert during class when he uses TI-Smartview to randomly select them to write their answers on the board. He claimed that this attitude was developed because he noticed a female student "taking the homework a little bit more seriously" because she was afraid she was going to be selected to write her answers. Mr. Bryant detected a mental attitude of "Ah, it's going to be me," which he feels led this student to work harder on assignments and come to class more prepared.

In the second stimulated recall interview (James Bryant, personal communication, October 5, 2010), Mr. Bryant discussed his beliefs about two attitudes related to TI-

Smartview. Mr. Bryant mentioned that he used the virtual TI-83 at another school where he taught. From using the virtual TI-83 and comparing it with TI-Smartview, Mr. Bryant noticed that the visual representations of TI-Smartview are nicer because he "can make the home screen larger" and he can show "every step being pressed." Mr. Bryant also stated that using TI-Smartview himself showed him that the program loads slowly. To compensate for this delay, Mr. Bryant loads TI-Smartview at "the beginning of the day and just leaves it open."

Causes of James Bryant's attitudes toward interactive whiteboards. Mr. Bryant only elaborated on the development of his attitudes about interactive whiteboards during his first stimulated recall interview (James Bryant, personal communication, September 10, 2010). In this interview, Mr. Bryant discussed two different experiences which led to the development of a couple of attitudes associated with the Smartboard. In the first story, Mr. Bryant said, "I used to put my notes in Microsoft Word and hold my notes and write them on the board." Mr. Bryant stated that he rewrote the same notes every year when he had to present the content with a new group of students. This experience led to Mr. Bryant's second story, in which he tried using an overhead projector. Mr. Bryant often sat to write the notes on the overhead. He stated, "I just can't sit still, that's just not my nature." He went onto state, "I like to be at the board, I like to be walking around." By comparing his experiences with Microsoft Word and the overhead projector to the Smartboard, Mr. Bryant developed his attitudes that the Smartboard makes it easier to save material and move about the class freely while teaching the course content.

Causes of James Bryant's attitudes toward the Internet. In the first stimulated recall interview (James Bryant, personal communication, September 10, 2010), Mr. Bryant discussed why he believes it is "good for students" when he posts his lessons on the Internet. Mr. Bryant claimed that in high school, "I wouldn't be able to read my own notes," and he feels that some of the students in his class also struggle with penmanship. Therefore, the Internet allows these students to reread anything that they are unable to understand in their own set of notes. Mr. Bryant discussed how in some cases, students misplace their homework assignments and "if a student doesn't have their homework, they can get on my website and go to the last slide where I've posted it." Mr. Bryant also described a mother who wanted to assist her child but did not understand the mathematical content. As a result, Mr. Bryant pointed her to the online version of his lessons. The mother told him, "Thanks for posting that because I don't know this math and I'm looking through your notes and it makes sense."

In the second stimulated recall interview (James Bryant, personal communication, October 5, 2010), Mr. Bryant discussed why he believes there are challenges to meaningfully employing the Internet as an instructional device. Mr. Bryant stated that in the past, when he heard about websites or videos designed to enhance student learning, he tried to access them, "but everything is blocked here." When he did find websites that he had access to, he needed to sign up for a computer lab. On several occasions, however, the "computer labs were already booked," and he was unable to use them. Given the inconsistencies in when computer labs are available, Mr. Bryant stated, "It's hard to do something every three or four weeks and be effective."

Causes of Peter Clark's attitudes toward graphing calculator projectors. In the first stimulated recall interview (Peter Clark, personal communication, September 19, 2010), Mr. Clark mentioned his belief behind why graphing calculator panels are critical in teaching students how to employ technology. Mr. Clark claimed that his students already know how to solve specific types of math problems. Therefore, his students "have in my mind what answers should look like." Mr. Clark explained that graphing calculators provide his students with further evidence that these answers are correct. However, Mr. Clark noticed that several of his students were using their graphing calculator incorrectly. For this reason, he started utilizing a graphing calculator panel to help students eliminate some of their common mistakes. Mr. Clark explained, "If I gave you a back hoe, I would have to teach you how to use the back hoe. I have to teach you how to use the technology. Sometimes students use the tools in math incorrectly." He stated that as students learn how to utilize their graphing calculators through the panel, they learn how these technological devices can "support what they have already learned."

In the second stimulated recall interview (Peter Clark, personal communication, October 3, 2010), Mr. Clark discussed his beliefs about two attitudes associated with graphing calculator panels. Mr. Clark explained that teaching shortcuts is necessary because he feels his students are "shortcut method kids." He noticed in the computer lab that students utilize "control v" when pasting something onto a document rather than "going up to edit, coming down to copy, and going to paste." Mr. Clark stated that if there is a way to show students how to do something faster, then the students want to see it. A graphing calculator panel provides him with an opportunity to teach short-cuts on the calculator. Mr. Clark also discussed why he thinks that having a concrete item in his hand is more effective for teaching students how to employ their calculator than a computer program is. He stated that utilizing a computer program is "kind of like teaching them how to use a shovel by holding a rake." Mr. Clark explained that by teaching with the panel, he is able to educate students about their calculator with a calculator as opposed to a keyboard.

Causes of Peter Clark's attitudes toward interactive whiteboards. Mr. Clark only elaborated on the development of his attitudes about interactive whiteboards during his second stimulated recall interview (Peter Clark, personal communication, October 3, 2010). In this interview, Mr. Clark explained how he discovered that writing directly onto a television screen with an erasable marker is an effective teaching tool. He mentioned that this idea originated when he was coaching football. One day, Mr. Clark was watching the film from the previous game with his players. The film was playing on a videocassette recorder (VCR) and being projected onto a television screen. As Mr. Clark was watching the film, he stated, "I was upset and I walked up to the TV screen and took the pen and went, this guy's got to block here." He explained that everyone in the room understood exactly what he was stating as he wrote on the television screen. For this reason, Mr. Clark began writing on the television screen when teaching his math classes. From his perspective, writing on the television screen benefits student learning because "it grabs their attention."

Causes of Peter Clark's attitudes toward the Internet. In the first stimulated recall interview (Peter Clark, personal communication, September 19, 2010), Mr. Clark discussed why he thinks that showing video clips from the Internet exposes students to opportunities to learn outside the classroom. Mr. Clark claimed that these videos are available to anyone because they are on the Internet. Therefore, if students are struggling to learn from Mr. Clark, they can go to the Internet for instruction. Mr. Clark stated, “I am not the ruler of the classroom. I’m just the person who gets information out to the class.” He explained that students can go to the Internet to “hear a speaker that doesn’t cost a dime and takes five seconds to set up.”

In the second stimulated recall interview (Peter Clark, personal communication, October 3, 2010), Mr. Clark discussed when he began to realize the importance of the Internet in his students’ lives. He claimed that it started by observing his own children. Mr. Clark noticed that his children “get up in the morning and before they clean up for the day or eat breakfast or whatever, they check their email or the Internet.” He maintained that seeing his children using Facebook and MySpace led him to employ blogs as a mode of instruction. Mr. Clark said, “They already do it. They blog about their relationships, they blog about things they’re going to do, have done, and will do.” He stated that he wanted to introduce blogs in his math classes because they are in the “students’ world.” Mr. Clark also told a story about why he feels that blogging is effective. He explained that as he was walking off the football field one Friday evening, one of his students yelled, “Coach Clark, during the game I figured out how to use my I-Phone to blog onto my Google blog.” Mr. Clark argued that the Internet must be an effective teaching tool if a student is working on math on a Friday evening.

Research Question Four

The fourth research question looked at the participants’ perspective on their own self-efficacy towards using technology for instruction. Through a structured interview, the participants rated their overall self-efficacy with regard to employing graphing calculator projectors, interactive whiteboards, and the Internet. These ratings were from 1 to 4, with 1 representing not confident, 2 denoting somewhat confident, 3 characterizing confident, and 4 symbolizing very confident. The participants also described the rationale for their ratings and discussed how they felt that their self-efficacy could be improved. It is important to note that I was not trying to prove that enhanced self-efficacy increases the likelihood of people utilizing technology. Research on that topic has already revealed that personal experience, vicarious learning, goal setting, and hands-on tasks improve self-efficacy and increase the likelihood of technology being employed (Mackey & Parkinson, 2010; Morales et al., 2008; Wang et al., 2004). However, as research has shown that there is a correlation between self-efficacy and behavior, I wanted to give the participants an opportunity to discuss methods for improving their own self-efficacy associated with using technology for instruction.

For this study, self-efficacy was defined as an individual's confidence that he or she can use technology for instructional purposes. As confidence can have unique meanings to various people, the first question asked the participants to define self-confidence with regard to using technology for instruction. Knowing how the participants defined self-confidence provided the vantage point for their answers to the remaining interview questions.

How Stacy Barber defined self-confidence. In Ms. Barber's self-efficacy interview (Stacy Barber, personal communication, May 4, 2011), she was asked to define self-confidence in the context of using technology for instructional purposes. Ms. Barber expressed that people are self-confident if "they know how to operate the system correctly and they know how to apply it to whatever they are teaching."

Stacy Barber's self-efficacy towards using graphing calculator projectors. The next seven questions of Ms. Barber's self-efficacy interview focused on graphing calculator projectors. Ms. Barber rated herself as being confident in using graphing calculator projectors as an instructional device (Stacy Barber, personal communication, May 4, 2011). She stated, "I think I know how to use them, but there are some things about graphing calculators that I still haven't learned." Ms. Barber felt most confident in modeling the steps for solving problems on a graphing calculator projector. She claimed, "For the most part, my students don't know how to use their calculator and I think that modeling the steps shows them how to use it." Ms. Barber was least confident in using the probability features of a graphing calculator projector. She stated, "I know very little about how to do probability on the calculator. If students asked me questions about how to do probability on the projector, then I'm not very confident that I could answer those questions."

Mr. Barber expressed that she feels more confident using her graphing calculator projector as a result of her experiences (Stacy Barber, personal communication, May 4, 2011). She said, "With the projector being an extension of regular graphing calculators, I feel very confident as I have used those for such a long time." Ms. Barber had never observed another educator teaching a class where a graphing calculator projector was employed. The only goal that she had set with regard to using a graphing calculator projector was to "pull it out whenever a lesson dictates that I should do so." Having this goal did not give her more confidence in her ability to utilize graphing calculator projectors for instruction. Ms. Barber also claimed that she had never taken a professional development class on this device and school leaders had never required her to employ a graphing calculator projector for instruction.

Stacy Barber's self-efficacy towards using interactive whiteboards. The next seven questions of Ms. Barber's self-efficacy interview focused on interactive whiteboards. Ms. Barber rated herself as being very confident in using interactive whiteboards as an instructional device (Stacy Barber, personal communication, May 4, 2011). She claimed that she is most confident at projecting "skeletal notes" onto the whiteboard. Ms. Barber defined skeletal notes as "notes that have spaces for students to fill in vocabulary words or other examples and they are very helpful with organization." She also said that there were no strategies that she could think of where she lacked confidence, although she did acknowledge that she "rarely tries new strategies" when using the whiteboard.

Ms. Barber stated that she feels more confident in her ability to use an interactive whiteboard as a result of her own personal experiences with the device (Stacy Barber, personal communication, May 4, 2011). She claimed, "While I rarely try new things, I do feel good about my ability to use the program when new strategies are used in a lesson." Ms. Barber had observed other teachers utilizing the whiteboard, but those observations did not provide any additional confidence as the teachers "weren't doing anything that I didn't already know how to do." She had never set goals for herself with regard to using specific strategies when employing interactive whiteboards for instruction. Ms. Barber also stated that she had never taken part in professional development related to interactive whiteboards and her school did not have a policy that mandated that she use it. However, Ms. Barber expressed that she would feel "behind in the times" if she did not utilize an interactive whiteboard in her classroom.

Stacy Barber's self-efficacy towards using the Internet. The next seven questions of Ms. Barber's self-efficacy interview focused on the Internet. Ms. Barber rated herself as being somewhat confident in using the Internet as an instructional device (Stacy Barber, personal communication, May 4, 2011). She said, "I feel confident using it personally, but I don't feel confident in finding the resources that are available through the Internet or in using the search tools to locate those resources." Ms. Barber explained that she is most confident at finding worksheets and images on the Internet. She stated, "I have one website that I go to that has a lot of different worksheets and I believe that showing images, such as conic sections, really helps the students." Mr. Barber is least confident at integrating websites into her lessons. She claimed to be uncertain where to locate interactive sites and "extremely uncomfortable trying to use them when they are found."

Ms. Barber is neither more confident nor less confident in using the Internet based on her own experiences (Stacy Barber, personal communication, May 4, 2011). She expressed that she enjoys finding new websites, but she gets "frustrated conducting searches" because she is unable to locate what she wants. Ms. Barber has observed other teachers using the Internet for instruction. She claimed that these observations made her feel more confident in her own ability to utilize the Internet because "it looked so easy that I felt capable of doing it myself." Ms. Barber had never set goals with regard to employing the Internet for instruction. Ms. Barber also expressed that she had never attended professional development related to integrating the Internet for instruction and her school did not have a policy that required teachers to employ the Internet in their classes. Nevertheless, Ms. Barber claimed to consistently use one website for document sharing, but no one required her to do so. Ms. Barber felt very confident in her ability to utilize this website from having worked with it in the past.

How Stacy Barber felt her self-efficacy could be enhanced. For the final question, Ms. Barber was asked to discuss strategies that would make her feel more confident in using graphing calculator projectors, interactive whiteboards, and the Internet as an instructional strategy. Ms. Barber believed that she would feel more confident using graphing calculator projectors in new ways if she was able to observe other teachers doing so (Stacy Barber, personal communication, May 4, 2011). She stated that she would especially like to "observe someone who used the projector to teach probabilities because I am not confident enough to try probabilities in front of my classes." Ms. Barber was unable to think of anything to enhance her confidence when employing interactive whiteboards. She claimed, "I have used them for so long and they really aren't difficult to use." Finally, Ms. Barber stated that her self-confidence regarding the Internet would increase if she attended a workshop being administered by another teacher who utilizes the Internet. She believed another teacher would be more effective than a certified expert as "teachers know how to work with children and would already know strategies for using the Internet in an instructional setting."

How James Bryant defined self-confidence. In Mr. Bryant's self-efficacy interview (James Bryant, personal communication, May 3, 2011), he was asked to define self-confidence in the context of using technology for instructional purposes. Mr. Bryant explained that a person has self-confidence “when they perceive themselves as being able to use technology well and they have comfort with it.”

James Bryant’s self-efficacy towards using graphing calculator projectors. The next seven questions of Mr. Bryant’s self-efficacy interview focused on graphing calculator projectors. Mr. Bryant rated himself as being confident in using graphing calculator projectors as an instructional device (James Bryant, personal communication, May 3, 2011). He said, “I would be more confident if I knew the ins and outs of the device, but there is just so much to know.” Mr. Bryant expressed that he is most confident in providing visual representations. He claimed that he “likes being able to quickly show students the relationship between a graph and an equation.” Nonetheless, Mr. Bryant stated that because he does not know every aspect of the graphing calculator, there are some questions that he cannot answer from students and he has less confidence in using the projector when those topics arise.

Mr. Bryant stated that he feels more confident in his ability to use a graphing calculator projector as a result of his own personal experiences with the device (James Bryant, personal communication, May 3, 2011). He claimed that having conversations with students while employing the graphing calculator projector allowed his confidence to grow because those interactions led to him gaining a deeper understanding of the device. Mr. Bryant said that he learned strategies for utilizing a graphing calculator projector through vicarious learning. He did not necessarily think that these observations increased his self-confidence, but they did make him “more aware of strategies that I was not using.” Mr. Bryant expressed that he had never set goals for himself with regard to employing a graphing calculator projector for instruction. He also claimed that he had never taken a professional development class on this device and school leaders did not require him to use a graphing calculator projector for instruction.

James Bryant's self-efficacy towards using interactive whiteboards. The next seven questions of Mr. Bryant's self-efficacy interview focused on interactive whiteboards. Mr. Bryant rated himself as being very confident in using interactive whiteboards as an instructional device (James Bryant, personal communication, May 3, 2011). He explained that "using a Smartboard feels natural to me because I've been using one for so long." Mr. Bryant stated that he feels most confident in his ability to "annotate for the visual learner." Prior to having an interactive whiteboard, Mr. Bryant said that he only taught in an auditory manner. However, by showing graphs and other images, both visual and auditory learners benefit from his lessons. Mr. Bryant also explained that while he does not lack confidence, he would like to update his lessons by finding "new interactive gadgets" to improve instruction.

Mr. Bryant stated that he feels more confident in his ability to use interactive whiteboards as a result of his own personal experiences with the device (James Bryant, personal communication, May 3, 2011). He claimed that "putting forth the time" made using interactive whiteboards a natural instructional strategy. Mr. Bryant said that he observed both "strong and weak" teachers using interactive whiteboards. When Mr. Bryant observed the strong teachers, he discovered strategies for employing interactive whiteboards that he was not using. However, these observations did not make him feel more confident in his own ability to use this technological device. Instead, the observations made Mr. Bryant want to try new things on his interactive whiteboard.

Mr. Bryant expressed that he has set written goals regarding interactive whiteboards. His goals stated that he needs to "include a mini-lesson, a summary, and make the lesson as interactive as possible." While these goals kept him focused, he did not believe they gave him more confidence in using whiteboards. Mr. Bryant also stated that the superintendent in his previous school district "required every teacher to include an opener, mini-lesson, work period, and summary" in their lessons. As a result, Mr. Bryant chose to include those items through his interactive whiteboard. The experiences of including those elements during every lesson gave Mr. Bryant more confidence in using the whiteboard for instruction.

James Bryant's self-efficacy towards using the Internet. The next seven questions of Mr. Bryant's self-efficacy interview focused on the Internet. Mr. Bryant rated himself as being somewhat confident in using the Internet as an instructional device (James Bryant, personal communication, May 3, 2011). He said, "So many things are blocked here that it's difficult to use the Internet at this school." If he were able to use the Internet more frequently, then he believed his confidence would improve. Mr. Bryant felt most confident in using websites that offer basic skills practice. He claimed that he can get to these websites quickly and immediately provide his students with problems that measure their basic mathematical skills. However, Mr. Bryant had very little confidence in his ability to use the Internet without "slowing the class down." Mr. Bryant discussed how it takes time for him to locate appropriate websites and once he does, he lacks confidence in navigating through them quickly. Therefore, he rarely uses the Internet as an instructional device.

Mr. Bryant felt that using the Internet made him less confident in his ability to employ it for instruction (James Bryant, personal communication, May 3, 2011). He stated, “I grew frustrated because there were times when links didn’t work or sites were blocked and everything was so hit or miss.” Mr. Bryant said that he became so bothered by the Internet that it became easier not to use it. He said that he had never observed another teacher utilizing the Internet, although he would like to do so. Mr. Bryant claimed to have set goals with regard to keeping Internet resources that he can get access to quickly. However, he rarely implemented them because he had a “difficult time establishing a routine.” Mr. Bryant registered for courses where he was expected to search for websites to be utilized in an instructional setting. He stated that these classes “never led to me using it and they certainly did not make me feel more confident in using the Internet for instruction.”

How James Bryant felt his self-efficacy could be enhanced. For the final question, Mr. Bryant was asked to discuss strategies that would make him feel more confident in using graphing calculator projectors, interactive whiteboards, and the Internet as an instructional strategy. Regarding graphing calculator projectors, Mr. Bryant thought observing other teachers would be helpful (James Bryant, personal communication, May 3, 2011). Mr. Bryant claimed that he has manuals, but “seeing it in action would really help.” When discussing interactive whiteboards, Mr. Bryant stated that he would like to attend a seminar related to these devices, “but only if it was an advanced tutorial, with all of the bells and whistles such as recording lessons and that sort of thing.” Mr. Bryant believed a workshop would give him the confidence to try more sophisticated strategies, but the seminars needed to emphasize advanced rather than basic skills. Finally, when talking about the Internet, Mr. Bryant claimed that he would like to observe teachers who use the Internet on a regular basis. He stated that "logistically, I need to see how people flow through their lessons when incorporating the Internet." Flowing smoothly from one topic to the next without any delay was where Mr. Bryant professed to need the most assistance and seeing others doing that would likely improve his confidence.

How Peter Clark defined self-confidence. In Mr. Clark's self-efficacy interview (Peter Clark, personal communication, May 5, 2011), he was asked to define self-confidence in the context of using technology for instructional purposes. Mr. Clark explained that people have self-confidence when "they feel that they have the ability to adjust and overcome deficiencies in technology." He stated, "Things are going to mess up and when that happens, people with self-confidence have the ability to troubleshoot the problem and proceed with the lesson."

Peter Clark's self-efficacy towards using graphing calculator projectors. The next seven questions of Mr. Clark's self-efficacy interview focused on graphing calculator projectors. Mr. Clark rated himself as being very confident in using graphing calculator projectors as an instructional device (Peter Clark, personal communication, May 5, 2011). He explained that there "is nothing that happens with these projectors that I don't feel that I can deal with." The only drawback that Mr. Clark revealed was in some instances, there are "syntax errors" that arise, but those errors do not cause him to panic. Mr. Clark is most confident in using the graphing calculator projector as a visual to represent data. He stated, "Visuals help the students interpret data differently and I try to incorporate them in most of my lessons." Mr. Clark is least confident with intricate steps for statistical analysis. He explained, “There seems to be two learning curves, one for the material and another for how to use the projector correctly.” However, Mr. Clark claimed that he continually tries to use the projector for statistical analyses in spite of the complicated steps that are involved.

Mr. Clark claimed that his personal experiences with a graphing calculator projector made him more confident in using the device (Peter Clark, personal communication, May 5, 2011). He stated, “I am not afraid to turn it on and mess up because I know that I can deal with it.” Mr. Clark said that he has observed other teachers using a graphing calculator projector. He explained that while what they were doing was “neat or interesting,” the strategies being used did not give him any more confidence in his own ability to use these projectors. Mr. Clark expressed that he has never set goals for himself with regard to employing a graphing calculator projector for instruction. He claimed that he was given the opportunity to use graphing calculator projectors at mathematics conferences and that those experiences increased his belief that he could employ them. Mr. Clark stated that school administrators have asked him to conduct professional development activities associated with a graphing calculator projector. In preparing tasks for those activities, he became more confident in his ability to use this technological device.

Peter Clark’s self-efficacy towards using interactive whiteboards. The next seven questions of Mr. Clark’s self-efficacy interview focused on interactive whiteboards. Mr. Clark rated himself as being very confident in using interactive whiteboards as an instructional device (Peter Clark, personal communication, May 5, 2011). He said, “I don’t have a problem playing with the technology either at home or at school and I'm not sure that everyone is willing to play with the software." Mr. Clark is most confident in using an interactive whiteboard for setting up notes or repetitive tasks that take place during every class period. On the other hand, Mr. Clark is least confident in using the whiteboard to show "flash movies." He explained, "I think these are difficult to use because they are in a format that I am unaccustomed to using and they slow me down."

Mr. Clark's personal experiences with an interactive whiteboard gave him more confidence in using this device (Peter Clark, personal communication, May 5, 2011). He said that he has used PowerPoint for a longer period time than he has had access to an interactive whiteboard. Due to his experiences with PowerPoint, he claimed to feel very confident uploading PowerPoint lessons onto his interactive whiteboard. Mr. Clark stated that he has observed other teachers using interactive whiteboards. However, the biggest issue with these observations was not confidence, but remembering every step for a given activity. He claimed that "confidence was not the issue, I just couldn't remember everything." Mr. Clark expressed that he did set a goal of saving all of his PowerPoint lessons as a Portable Document Format (PDF) file. By doing this, Mr. Clark explained that he could save the PDF files onto a flash drive and "use them on any Smartboard in the school." However, this act of saving PowerPoint presentations as a PDF file did not give him more confidence in using interactive whiteboards. Mr. Clark also claimed that he had never taken a professional development class on this device and school leaders did not require him to use an interactive whiteboard for instruction.

Peter Clark's self-efficacy towards using the Internet. The next seven questions of Mr. Clark's self-efficacy interview focused on the Internet. Mr. Clark rated himself as being very confident in using the Internet as an instructional device (Peter Clark, personal communication, May 5, 2011). He claimed to feel confident utilizing the Internet because he employs it “all the time and I’m constantly searching for sites from I-tunes, to Google, to just basic searches. Mr. Clark said that he is most confident in his ability to “use the Internet to create a hook, a way to show students how the content fits into the real world.” He claimed to be very confident in every aspect of the Internet and he could not think of any strategy that he lacked confidence in attempting.

Mr. Clark explained that using the Internet made him more confident in his ability to employ it for instruction (Peter Clark, personal communication, May 5, 2011). He stated that since he utilizes it all the time, he knows that he is capable of using it in the classroom. Mr. Clark mentioned that he has observed other people employing the Internet for instruction. He said that “seeing people was how I first learned about using the Internet in the classroom.” While these observations did make Mr. Clark want to integrate the Internet in his own classes, they did not increase his self-confidence.

Mr. Clark stated that one of his main goals for employing the Internet for instruction was to incorporate “Google Blogger.” He believed that allowing students to Blog about math would improve their scores on the written portion on the final exam. However, Mr. Clark noticed that scores became worse because the students were “so dependent on technology and they hadn’t practice writing.” For this reason, Mr. Clark felt less confident with regard to the impact of technology on student achievement, but his self-confidence remained intact.

Mr. Clark claimed that he has been asked by school administrators to instruct other teachers on how to use the Internet in the classroom. He said, “I have created professional development that showed teachers how to use QuizStar and Google documents and I would like to do even more." By creating professional development activities for other teachers, Mr. Clark stated that his self-confidence was enhanced regarding the use of the Internet for instruction.

How Peter Clark felt his self-efficacy could be enhanced. For the final question, Mr. Clark was asked to discuss strategies that would make him feel more confident in using graphing calculator projectors, interactive whiteboards, and the Internet as an instructional strategy. Mr. Clark claimed that there were no strategies that could enhance his self-confidence associated with using graphing calculator projectors and the Internet (Peter Clark, personal communication, May 5, 2011). With regard to using interactive whiteboards, Mr. Clark said that professional development that focused on "advanced topics" could enhance his self-confidence. Mr. Clark acknowledged that issues may arise when professional development concentrates on advanced concepts because "only two or three people may attend."

Summary

The pre-observational survey and stimulated recall interviews revealed the attitudes of the three participants in this study. Results indicated that the participants hold an overall positive view of graphing calculator projectors, interactive whiteboards, and the Internet. In spite of these positive attitudes, the classroom observations revealed that all three teachers spend the majority of their time employing interactive whiteboards when compared to graphing calculator projectors and the Internet. Results also showed that the participants use graphing calculator projectors more frequently than the Internet.

Four common themes were found regarding the impact of attitudes on the amount of time that technology is used for instruction. The first theme showed that when teachers have positive attitudes toward the impact of graphing calculator projectors on student learning, they are unlikely to use them with a small group of students. Regarding the second theme, the results indicated that when teachers have positive attitudes toward the influence of interactive whiteboards on student learning, students are likely to use them in a limited capacity. The third theme revealed that when teachers have positive attitudes toward the impact of interactive whiteboards on student learning, they are likely to use them as a screen to project notes and to add onto these notes using whiteboard pens. With regard to the fourth theme, when teachers have positive attitudes toward the influence of the Internet on student learning, they are likely to use it sparingly.

Two additional themes were also discovered. The first additional theme was in some cases, teachers had the same attitudes but utilized technology differently. Regarding the second additional theme, the more experienced teacher utilized the Internet in a greater capacity than the less experienced teachers. However, it is important to note that there was only one participant for each level of experience. Therefore, it is unlikely that this theme could be transferred to other educational settings.

The stimulated recall interviews revealed that the participants hold beliefs regarding the root causes of specific attitudes related to technology. All three participants explained how their personal experiences with technology contributed to the formation of their attitudes. Mr. Bryant and Mr. Clark also described scenarios in which their attitudes were formed through relationships with other people.

In the self-efficacy interviews, both Ms. Barber and Mr. Bryant claimed that they were confident in using graphing calculator projectors, very confident in utilizing interactive whiteboards, and somewhat confident when employing the Internet as an instructional device. On the other hand, Mr. Clark stated that he was very confident in using all three technological devices for instruction. With regard to improving their self-efficacy, only two strategies were discussed: professional development and vicarious learning. Ms. Barber said that her self-confidence could be enhanced towards graphing calculator projectors by observing other teachers and for the Internet by attending a workshop. Mr. Bryant exclaimed that watching other teachers would enhance his self-efficacy towards using graphing calculator projectors and the Internet, but advanced professional development could improve his self-confidence associated with interactive whiteboards. Mr. Clark only discussed an interactive whiteboard and he expressed that professional development on advanced topics could enhance his confidence when using this device.

The next chapter focuses on the implications of this research project. There is also a discussion about how the results of this study correspond with relevant research. The chapter concludes with information about additional theories and testing instruments that were considered for this study, as well as the limitations for this study and recommendations for future research.

CHAPTER FIVE: FINDINGS AND DISCUSSION

Billions of dollars have been spent on educational technology throughout the United States and the world (Norris et al., 2003). In the United States alone, the ARRA established that $650 million would be invested in educational technology from 2009-2019 (Pelosi, 2009). Despite this investment, studies indicate that many educators fail to utilize technology (e.g., Middleton & Flores, 1997; Thomas, 2006). When technology is employed, teachers often prioritize their own needs over the needs of their students (Bebell et al., 2004). In fact, educators commonly use technology for non-instructional purposes such as maintaining records, emailing parents, or creating assessments (National Center for Education Statistics, 2000).

Rather than focusing on how teachers employ technology for non-instructional purposes, the focus of this study was on how technology is used for instruction. The purpose was to determine whether the attitudes of teachers influence the amount of time in which technology is utilized for instruction. This study concentrated on three types of technology: graphing calculator projectors, interactive whiteboards, and the Internet. Three Algebra 2 teachers from the same high school were chosen to participate in this study. Each participant completed a pre-observational survey, was observed teaching six different lessons, and took part in two stimulated recall interviews. Teacher attitudes were determined through the pre-observational survey and the stimulated recall interviews. The six classroom observations were videotaped and coded to determine unique strategies in which technology was employed for instruction. As different methods were utilized, a stopwatch was used to measure the exact amount of time each strategy was employed.

Summary of Findings

Four common themes were discovered in this study. The results showed that positive attitudes toward graphing calculator projectors do not lead teachers to using them with a small group of students while the remainder of the class completes a task independently. Another theme was that when teachers have positive attitudes regarding the benefits of interactive whiteboards on student learning, students are likely to use them in a limited capacity. The third theme was that positive attitudes toward interactive whiteboards lead teachers to use them as a screen to project notes and add onto these notes using whiteboard pens. The final theme was that positive attitudes toward the Internet lead teachers to utilize it sparingly when instructing their students.

Two additional themes were also observed. Regarding the first theme, in some instances the three participants expressed the same attitude toward a technological device. In spite of their common attitudes, the manner in which this device was utilized varied from person to person. Therefore, having a common attitude does not ensure that technology is going to be used in the same manner from individual to individual. With regard to the second theme, more experienced educators are likely to use the Internet in a greater capacity than educators in the early or middle stages of their teaching careers. However, due to the study's small sample size it will be difficult to transfer this theme to other educational settings.

Implications of the Study

This case study revealed the attitudes of three Algebra 2 teachers with regard to employing graphing calculator projectors, interactive whiteboards, and the Internet for instruction. The study also showed the amount of time that these technological devices were used by the participants when educating their students. Based on the results of this case study, several implications exist that can assist school leaders in meeting the needs of their teachers, which in turn can enhance teacher instruction.

Implication one. This study revealed that having positive attitudes toward technology does not necessarily lead to teachers employing technology for instruction. With regard to the four common themes discovered in this study, themes one, two, and four involved the participants having positive attitudes about a technological device but using that instrument in a limited capacity. These themes indicate that the participants believe it is beneficial to use technology, but in some instances neglect to do so. For this reason, school leaders need to create professional development opportunities aimed at showing teachers how to use technology more effectively.

For instance, the first theme demonstrated that while the participants expressed positive attitudes toward graphing calculator projectors, none of the teachers used them with a small group of students while the remainder of the class completed a task independently. However, Doerr and Zangor (2000) revealed that modeling problems on a graphing calculator to a small group of students is an effective teaching practice. Simmt (1997) discovered that visual representations on graphing calculators assist students in making generalizations about data. Based on these studies, school leaders can generate professional development opportunities that show mathematics teachers how to select and work with small groups of students in their classes. With these groups, teachers can model the process for summarizing data, drawing conclusions, and solving problems on a graphing calculator projector while the remainder of the class completes a task on their own. This type of professional development will meet the needs of math teachers who are uncertain how graphing calculator projectors can be utilized as a means of instruction when students work independently in their classes.

The second theme showed that while teachers have positive attitudes regarding the benefits of interactive whiteboards on student learning, educators allow students to use these whiteboards in a limited capacity. The only manner in which Ms. Barber and Mr. Bryant allowed their students to use an interactive whiteboard for instruction was to write their answers on the board. Mr. Clark's students never used the interactive whiteboard. Thus, school leaders can create professional development activities that train teachers on different strategies that permit students to use interactive whiteboards for instruction. Such strategies include having students play games or complete multiple choice assessments on the whiteboard (Shenton & Pagett, 2007), having students teach lessons on the whiteboard (Bennett & Lockyer, 2008), or placing students into small groups and allowing them to present information using any tool on the whiteboard that they wish (Warwick & Kershner, 2008).

The fourth theme revealed that while teachers have positive attitudes toward the Internet, they are likely to use it sparingly when teaching their students. Ms. Barber used the Internet to present the student textbook on one occasion. Mr. Bryant never utilized the Internet for instruction. Mr. Clark employed the Internet to show his own blog and a student's blog on one occasion, for less than one minute. He also accessed videos through the Internet.

Although Mr. Clark used the Internet in more ways than Ms. Barber and Mr. Bryant, there are additional strategies that these educators can use when implementing the Internet as an instructional device. Such strategies include accessing instructional modules when teaching a unit (Habash et al., 2006), allowing students to use the Internet as a library to discover information about a given topic (Barabash et al., 2003), and utilizing Java Applets to show students how models change as data is manipulated (Banchoff, 2009). School leaders can generate professional development opportunities that demonstrate how to effectively implement these strategies in order to improve the likelihood of teachers using the Internet for instruction.

Implication two. The third theme that was discovered was that when teachers have positive attitudes toward interactive whiteboards they are likely to use the whiteboard as a screen to project class notes and to add onto these notes using whiteboard pens. These two cases were the only instances in which technology was commonly employed by all three participants.

While using pens to add onto projected notes is an interactive feature of the whiteboard, utilizing the whiteboard as a screen is not. Teachers can bring students to the whiteboard to underline phrases or to give presentations (Nolan, 2009; Warwick & Kershner, 2008). Educators can also show photos or videos, play music or games, display websites, provide questions, and give assessments on an interactive whiteboard (Preston & Mowbray, 2008; Shenton & Pagett, 2007; Wood & Ashfield, 2008). While specific participants employed some of these teaching strategies, there was never an instance where all three of the participants utilized a common interactive strategy other than using whiteboard pens to add onto class notes. School leaders can generate professional development opportunities that show teachers how to more effectively employ a whiteboard in an interactive manner as opposed to a screen. These types of professional development will also improve the chances of uniformity among teachers regarding the manner in which whiteboards are used.

Implication three. This case study also revealed that in some cases, teachers have common attitudes toward technology. In spite of these shared beliefs, the manner in which technology was utilized differed from one teacher to the next. Therefore, school leaders should not expect every teacher to require the same amount of professional development on a given topic. In certain instances, specific teachers will require more professional development in a particular area than their colleagues.

For instance, in this study the participants agreed that showing visual representations on graphing calculator projectors enhance student learning. Nevertheless, the amount of time the participants utilized graphing calculator projectors as a visual representation varied during the six classroom observations. Ms. Barber used the graphing calculator projector as a visual representation for 2 minutes 26 seconds, Mr. Bryant for 0 minutes 0 seconds, and Mr. Clark for 23 minutes 46 seconds. These results suggest that Ms. Barber and Mr. Bryant require more professional development than Mr. Clark regarding the use of graphing calculator projectors as visual representations.

In another case, the participants strongly agreed that interactive whiteboards provide students with visual representations that are necessary for student learning. In spite of this agreement, Ms. Barber offered visual representations on the interactive whiteboard for 14 minutes 5 seconds, Mr. Bryant for 2 minutes 46 seconds, and Mr. Clark never used the interactive whiteboard to provide visual representations. These results indicate that Mr. Bryant and Mr. Clark need more professional development than Ms. Barber with regard to utilizing interactive whiteboards as visual representations.

Implication four. This case study also revealed that in some instances, a participant expressed conflicting attitudes regarding a specific type of technology. In some of these cases, the participants chose not to use technology in spite of their positive views. Therefore, if teachers feel stronger about a negative belief than a positive one, then they are less likely to employ technology. School leaders need to understand that some attitudes carry more weight than others. If school leaders want their teachers to use technology, then they need to generate professional development to highlight its benefits as well as assuage the teachers' negative viewpoints.

For instance, in her pre-observational survey, Ms. Barber expressed conflicting attitudes associated with the Internet. Ms. Barber agreed that the Internet enhances student critical thinking skills and allows teachers to meet the individual needs of more students. On the other hand, she disagreed that the Internet allows teachers to enrich their lessons and allows students to gain a deeper understanding of course content. Despite her positive attitudes, Ms. Barber only used the Internet to access the students' textbook on one occasion during the six classroom observations. In this instance, Ms. Barber's negative attitudes may have played a greater role than her positive ones in determining whether the Internet was employed as an instructional device. If school leaders created professional development opportunities that demonstrated how teachers can enrich their lessons and how students can gain a deeper understanding of course content through the Internet, then Ms. Barber may be more inclined to use it when instructing her students.

During his second stimulated recall interview (James Bryant, personal communication, October 5, 2010), Mr. Bryant also discussed opposing views related to the Internet. Mr. Bryant stated that websites are beneficial to student learning. He also claimed that “finding a way to use them in a way that I think is meaningful is hard for me.” During the six classroom observations, Mr. Bryant never used the Internet for instruction. In this case, Mr. Bryant’s negative attitudes may have played a greater role than his positive ones with regard to using the Internet. If school leaders generated professional development that showed Mr. Bryant how to use the Internet in a meaningful way, then he may be more inclined to employ it as an educator.

Implication five. This case study also suggested that attitudes are not the only factor that impacts technology usage. In some cases, the participants had positive attitudes toward technology, but circumstances did not allow them to utilize it. The TPB emphasizes that perceived control is a factor in determining whether a behavior takes place (Ajzen, 1991). When people do not have control over an action, then they are unlikely to take part in that behavior. Therefore, to increase the likelihood of technology being used school leaders need to consider factors that prevent their teachers from using it.

For instance, during Mr. Bryant’s second stimulated recall interview (James Bryant, personal communication, October 5, 2010), he claimed that accessing videos through the Internet is a good way to introduce a topic. Mr. Bryant also stated that “everything is blocked here” and, therefore, he is unable to show videos from the Internet. In another case, Mr. Bryant said that it is beneficial to allow students to prepare for assessments through Internet websites. Nevertheless, when Mr. Bryant wished to take his students to the computer lab so that they could prepare for a test, the “computer labs were already booked,” and he was unable to go. In both of these instances, Mr. Bryant expressed positive attitudes toward employing the Internet as an instructional device, but was prevented from doing so. If school leaders show Mr. Bryant websites with unblocked videos or provide him with strategies for gaining access to computer labs, then he will have more control over whether the Internet is utilized for instruction.

During Mr. Clark's first stimulated recall interview (Peter Clark, personal communication, September 19, 2010), he claimed that he was unable to use his Smartboard because the light bulb was dim in the projector to which the Smartboard was connected. He elaborated further that "even when I turn out all the lights, it's still hard to see." Therefore, Mr. Clark was unable to use his Smartboard in spite of his positive attitudes toward interactive whiteboards. Fortunately, Mr. Clark had access to a television and overhead projector, which he was able to use as an interactive device. However, if these technological devices were unavailable, then teaching on a dry-erase board was his only remaining option. If school leaders choose to purchase a new light bulb for Mr. Clark's Smartboard projector, then he will have more control over whether he employs it as an interactive device.

Implication six. In some instances, administrators may not have the capital to implement professional development. For this reason, school leaders need to consider alternative approaches on how to assist their teachers in more effectively using technology. Administrators can encourage faculty members to share with their colleagues during department or faculty meetings the teaching strategies that are used in the classroom. When sharing these approaches, teachers can express how they utilize technology in the classroom and demonstrate to their coworkers how that technology is employed. School leaders can generate a list of free chat rooms that can assist teachers in learning how to use technology. In turn, teachers can go to these websites, log onto an

Internet chat, and ask questions related to a specific technological device. Administrators should also consider creating a mentoring program in which a mentor is able to assist other teachers in more effectively utilizing technology. In some cases, the mentor may be a certified professional, but in other instances it may be a faculty member with experience using certain types of technology. It is also important for administrators to give teachers the opportunity to practice the strategies that they have learned through these alternative learning environments. By implementing technology in a practice setting, teachers may feel more inclined to utilize it when instructing their students.

How the Results Compare with Research

How teachers use graphing calculator projectors. Farrell (1996) discovered that when using graphing calculators, teachers change their role from lecturer to consultant. Alternatively, Simmt (1997) observed that the roles of teachers did not change when graphing calculators were used. In this case study, Ms. Barber and Mr. Clark used graphing calculator projectors to stimulate class discussion. Their behavior supports Farrell's (1996) finding that teachers lecture less when using graphing calculators. Mr. Bryant employed a graphing calculator projector to randomly select students to write their answers on the board. As this strategy allowed Mr. Bryant to assess student work, it also supports Farrell's conclusion.

How teachers use interactive whiteboards. Wood and Ashfield (2008) observed that whole-class instruction was commonly used when teaching with interactive whiteboards. These researchers also found that students play an inactive role during lessons when interactive whiteboards are employed. Ms. Barber, Mr. Bryant, and Mr. Clark never taught individual students when teaching from the interactive whiteboard. In every instance, they taught to the entire class by introducing a topic, projecting notes or handouts, writing answers, reviewing course content, providing visuals, or summarizing lessons. These results support Wood and Ashfield's research that educators teach to the entire class rather than individuals. On the other hand, the three participants also used the interactive whiteboard to stimulate interaction between themselves and their students. Furthermore, Ms. Barber and Mr. Bryant allowed students to write their answers directly onto the interactive whiteboard. These results differed from Wood and Ashfield's finding that students play an inactive role when educators teach from interactive whiteboards.

How teachers use the Internet. Barabash et al. (2003) discovered that there are two primary methods for teaching and learning through the Internet. In the first case, teachers use the Internet as an "online classroom" (p. 151) where they read articles, email assignments, and take part in Internet chats. Regarding the second situation, teachers utilize the Internet as a library of resources while instructing students face-to-face.

Ms. Barber only used the Internet to access the students' textbook. In this instance, Ms. Barber employed a resource directly from the Internet and, therefore, falls into the second scenario described by Barabash et al (2003). Mr. Clark allowed his students to use the Internet to complete an online survey, finish and submit assessments, and communicate through a blog. Each of these examples corresponds with the first situation discussed by Barabash et al. Mr. Clark also accessed Internet videos to present course content. This case falls into the second scenario mentioned by Barabash et al. As Mr. Bryant never employed the Internet, I was unable to determine whether he uses the Internet in a manner consistent with research. Nevertheless, the strategies used by Ms.

Barber and Mr. Clark do correspond with one of the two categories described by Barabash et al.

The impact of attitudes on technology use. Research shows that the impact of attitudes on a person's intent to employ technology varies. Venkatesh et al. (2003) discovered that attitudes associated with intrinsic motivation influence an individual's intent to use technology. Conversely, attitudes related to social and job expectations failed to impact intent. Lau and Woods (2008) observed that exposure to technology enhances positive attitudes. As attitudes improve, people intend to utilize technology more frequently. Thompson et al. (1991) discovered that some attitudes influence intent to use technology and others do not. With regard to attitudes associated with complexity, these attitudes do impact intent. On the other hand, attitudes do not influence intent when they relate to technology making work more interesting and enjoyable.

While this case study did not focus on intent, it did provide mixed results regarding the impact of attitudes on technology use. All three participants agreed that showing visual representations on graphing calculator projectors enhance student learning. Nonetheless, only Ms. Barber and Mr. Clark employed a graphing calculator projector as a visual representation of data. In this instance, the positive attitude appeared to have a greater influence on the behavior of Ms. Barber and Mr. Clark than on Mr. Bryant. The three participants also expressed positive attitudes toward the importance of interactive whiteboards on instruction. These attitudes led the educators to project notes and handouts on the interactive whiteboard when reviewing or teaching new content. Alternatively, these positive attitudes had little impact on the participants when it came to allowing their students to use the interactive whiteboard.

Findings in Relation to Theoretical Framework

The TPB emphasizes three determinates of behavior: attitudes, subjective norms, and behavioral control (Ajzen, 1991). This study concentrated mostly on attitudes, which is permissible because the impact of attitudes, subjective norms, and behavior control varies from one circumstance to the next (Ajzen & Fishbein, 2004).

The results of this study were mixed. In cases where the participants expressed a common attitude towards technology, the participants used the device for different lengths of time. Therefore, attitudes had a greater influence on some of the participants than on others. When considering all three participants, attitudes had a profound influence on the amount of time that interactive whiteboards were used for whole-class instruction. For instance, positive attitudes toward interactive whiteboards lead to participants using them to project notes onto a screen and adding onto those notes using whiteboards pens. On the other hand, examples were discovered where attitudes did not impact technology usage. One example was that positive attitudes toward graphing calculator projectors did not lead to teachers using them with a small group of students while the remainder of the class worked independently on assignments.

There were also cases where the participants expressed positive attitudes but were unable to use technology because of perceived barriers. For instance, Mr. Bryant was unable to access Internet videos because the school blocked websites he was interested in using. By including the element of behavior control, the TPB incorporates barriers as an influence on behavior. For this reason, it is important to note that attitudes are not the sole factor in determining actions. Therefore, it is necessary to consider elements in addition to attitudes when determining why people do or do not undertake given behaviors.

Other Theories Considered for this Study

For this study, the Theory of Planned Behavior (TPB) was used as the theoretical framework. Other theories were also considered, but it was determined that the TPB was best as it focused on attitudes as a determinate of behavior. The following section includes three additional theories that were reflected upon with regard to the theoretical framework of this project.

Technology Acceptance Model. The Technology Acceptance Model (TAM) was introduced "to provide an explanation of the determinants of computer acceptance" (Davis, Bagozzi, & Warshaw, 1989, p. 985). To justify the model theoretically, the creators adapted it from the Theory of Reasoned Action (TRA). Like the TRA, the TAM suggests that the use of computers is based on behavioral intent. On the other hand, instead of focusing on a range of attitudes and subjective norms, the TAM concentrates entirely on perceived usefulness and ease of use. Perceived usefulness refers to the "probability that using a specific application system" (p. 985) will enhance job performance. "The degree to which the prospective user expects the target system to be free of effort" (p. 985) corresponds with ease of use. When perceived usefulness and ease of use are positive, the likelihood of individuals using technology improves significantly.

Research indicates that the TAM does an acceptable job of predicting behavior (Mathieson, 1991). However, the model fails to account for any determinants of behavior other than perceived usefulness and ease of use. The TAM also neglects to consider social motivations and perceived barriers that lead or prevent people from employing technology in given situations. Given that the TAM only focused on two types of attitudes, I felt it was a too limited in scope for this research project.

Social Cognitive Theory. The Social Cognitive Theory (SCT) is a learning theory that explains how people obtain and preserve certain behavioral patterns (Bandura 1997). This theory views people as being proactive as opposed to reactive organisms who self-reflect, self-regulate, and self-organize before taking part in a given behavior (Bandura, 1986). The theory explains that personal, behavioral, and environmental factors influence behavior. Personal factors include cognitive, affective, and biological events. Behavioral factors consider an individual's competence or ability to do something. Environmental factors consist of social conditions or physical surroundings. The SCT emphasizes each of these factors equally. For this reason, all three elements should be considered when looking at the rationale behind an individual's behavior.

One of the main issues of the SCT is that it relies on multiple concepts of learning and therefore practitioners often use different combinations of these concepts in research (Prochaska, 2006). The theory is so broad in scope that different researchers may utilize the theory but emphasize different concepts. As this study focused specifically on attitudes and their impact on technology use, I felt that a more precise theory was best for this research project.

The Will, Skill, Tool for Teacher Integration Model. Knezek, Christensen, Hancock, and Shoho (2000) developed the Will, Skill, Tool Model (WST) for technology integration. The complete version of this model includes a student and teacher section. The teacher part of the model is referred to as the Will, Skill, Tool for Teacher

Integration Model (WiSTTI). Three different components are included in the WiSTTI. The first component is a person's will to use technology. Will is defined as a "self-actualized state of motivation, an internal self-generated desire resulting in an intentional choice" (McCombs & Marzano, 1990). A person's will is developed from such items as attitudes toward specific technological devices, high levels of self-efficacy, and beliefs associated with becoming better at teaching. The second component is skill, which is defined as "an acquired cognitive or metacognitive competency that develops with training and/or practice" (McCombs & Marzano, 1990). An individual's skill is cultivated through such things as professional development and personal experience in using technology. The third component of the WiSTTI is the term tool. Tool refers to having access to the technological device being integrated (Knezek et al., 2000).

The literature review for this study revealed that attitudes influence a person's intent to use technology. Furthermore, the purpose of this study was to determine the impact of attitudes on technology usage. As the TPB emphasizes attitudes leading to intent, and then intent leading to actual behavior, I chose the TPB for the study's theoretical framework. However, as the WiSTTI does provide a thorough model for technology integration, I acknowledge that this model was also appropriate for this research project. The only issue with using the WiSTTI for this study is the model fails to emphasize intent, whereas the TPB includes intent as a core component.

Other Testing Instruments Considered for this Study

This study considered the impact of teacher attitudes on the amount of time that technology was used for instruction. To determine teacher attitudes, a 28-item Likert-scale survey was created. A panel of experts was used to establish the survey's face and content validity (DeVellis, 1991). This testing instrument concentrated on attitudes associated with graphing calculator projectors, interactive whiteboards, and the Internet.

There was one additional testing instrument that was considered for this study. The following section includes a discussion of this questionnaire.

Teacher Attitudes Toward Computers Questionnaire. The Teacher Attitudes Toward Computers Questionnaire (TAC) was initially developed from 1995 to 1997 (Christensen & Knezek, 2009). This initial version included 284 items and had both Likert and Semantic-Differential-based questions. Since 1997, the TAC has undergone changes to reduce the number of testing items, but continue to maintain a high level of reliability. Based on the analysis of 1,179 teachers in 2003, teacher data in 2006, and preservice teachers preparation data in 2008, the questionnaire was reduced to 51 items. The researchers concluded that the 51-item version of the TAC "is a well-validated, reliable instrument for teachers' self-appraisal of their attitudes toward computers, worthy of continued use in multiple languages and cultural environments" (p. 143).

The TAC only measures teacher attitudes toward computers. For this study, teacher attitudes needed to be measured for graphing calculator projectors, interactive whiteboards, and the Internet. Therefore, the TAC was not an appropriate testing instrument for this research project.

Limitations and Future Research

This case study only focused on the impact of attitudes on the amount of time that teachers employ technology. Additional factors were not focused on that may influence technology usage. One such factor is perceived obstacles to technology use. Therefore, it is recommended that future research concentrate on barriers and whether teachers utilize technology with greater frequency when obstacles are removed.

Another limitation to this study relates to the participants. The research only included participants who were Caucasian and who taught at the same high school. It is recommended that future research focuses on participants of different ethnicities to determine whether cultural experiences influence technology use. Researchers should also concentrate on elementary and middle school teachers to establish whether the age of students impacts technology usage. Also, the highest degree of two of the participants was a bachelor's degree and for the third participant it was a specialist's degree. Therefore, it is recommended that future researchers only include teachers whose highest degree is the same.

As this school was situated in a community that had a median household income of $66,327 and 9.6% of the population living below the poverty level (United States Census Bureau, 2008b), it is suggested that future research focus on schools in lower income environments to determine whether socioeconomic status influences how technology is utilized by educators. The school was also located in a suburban community northeast of Atlanta, Georgia. Future research should concentrate on schools in rural or urban environments. It is also recommended that research focus on schools in different states or countries to establish the impact of culture on technology use.

Another limitation is that only Algebra 2 teachers were observed. Perhaps other mathematics classes provide teachers with greater opportunities to implement technology. Therefore, it is suggested that researchers replicate this study, but focus on different mathematics courses to determine whether results are consistent from one class to the next.

As this study concentrated on educators in three different stages of their teaching career, it is recommended that future research concentrate on only one stage. By focusing on only new teachers, educators with a few years of experience, or veteran teachers, researchers can look for common themes to determine how attitudes impact technology use at different stages of a person's teaching career.

Although the participants were observed teaching the same unit, the specific topics being observed within the unit were not always the same. For instance, Mr. Clark and Mr. Bryant were observed teaching a lesson on utilizing Cramer's Rule to solve a system of equations. On the other hand, Ms. Barber was never witnessed teaching a lesson on Cramer's Rule. When future researchers use more than one participant in their study, it is recommended that they observe educators teaching the same topics within a given unit to determine how attitudes influence technology usage for those topics.

The TPB includes subjective norms as an element that impacts behavior. Subjective norms are the perceived social pressures to engage in activities (Ajzen, 2000). In this case study, I was the mathematics department chair of the three participants. Therefore, the participants may have felt unintended pressure to employ technology given that their department chair was observing their classes. However, as the department chair, I did not hold a supervisory role over these teachers and I made no evaluations about their teaching performance. My role was simply to provide support, to facilitate between the administrators and the teachers, and to order supplies based on the department's needs. Nonetheless, future researchers should duplicate this study but not include participants over whom they have a relationship.

Summary

The results of this case study revealed five implications that can aid school leaders in meeting the needs of their teachers, which in turn can improve instruction. School leaders should create professional development opportunities that show teachers how to use technology more effectively. Professional development should also emphasize how to employ interactive whiteboards in an interactive manner as opposed to using them as screens to project handouts or class notes. The results also uncovered that in some instances, teachers with common attitudes utilized technology differently. Therefore, school leaders should not expect all of their teachers to require the same amount of professional development on a given technological device. The fourth implication is that school leaders need to generate professional development that stresses the benefits of technology as well as alleviate the teachers' negative viewpoints. A final implication is that attitudes are not the only factor that determines behavior. School leaders need to find ways to eliminate obstacles if they expect teachers to utilize technology on a consistent basis.

This case study supported Farrell's (1996) study, which showed that graphing calculators move teachers from lecturers to consultants. When compared to Wood and Ashfield's (2008) research, this case study provided mixed results. Wood and Ashfield found that teachers commonly use interactive whiteboards for whole-class instruction and that students play an inactive role in learning. This case study confirmed that teachers employ interactive whiteboards to instruct an entire class. However, students were actively involved in the learning process. Regarding the Internet, this study supported the findings of Barabash et al. (2003) that the Internet is utilized in two ways: as an online classroom and as a library of resources to instruct students face-to-face. Finally, the study supported the findings of Venkatesh et al. (2003) and Thompson et al. (1991) that in some cases attitudes influence technology use but in other instances they do not.

The TPB considers three determinates of behavior: attitudes, subjective norms, and behavioral control (Ajzen, 1991). This study focused primarily on attitudes. The findings indicated that common attitudes impacted the participants' use of technology differently. There was only one case where positive attitudes led all three participants to using technology in a common fashion. In this case, the participants expressed positive attitudes toward interactive whiteboards and this led to the participants using their whiteboards as a screen to project notes and adding onto these notes with whiteboard pens. There were no other examples where attitudes led all three participants to using technology in the same manner.

There were several limitations in this study. One such limitation was that it only focused on the impact of attitudes on behavior. Limitations associated with the participants also existed. These limitations included that the participants were all Caucasian, they were only observed teaching Algebra 2, and they taught at the same middle to upper class high school in a suburb of Atlanta, Georgia. Also, while the participants were observed teaching the same unit, they were not examined teaching similar lessons within that unit.

It is suggested that future research focus on additional elements which may influence behavior such as obstacles, subjective norms, or cultural experiences. It is also recommended that research concentrate on participants who are not Caucasian, who teach mathematics classes other than Algebra 2, who work in elementary or middle schools, who teach in low-income schools, who work in rural or urban communities, or who teach outside the state of Georgia. Finally, it is suggested that in studies with multiple participants, researchers observe educators teaching the same lesson to determine how attitudes influence technology usage for specific topics.

Conclusion

The purpose of this case study was to understand how the attitudes of Algebra 2 teachers influenced the amount of time in which technology was used for instruction. The results of this study varied. When the participants expressed a common attitude towards technology, the participants utilized the device for different amounts of time. Therefore, having a common attitude does not ensure that technology is going to be used in the same manner from person to person. In this case study, attitudes had a greater influence on some of the participants than on others.

Regarding common themes, the only instance where attitudes influenced all three participants in the same manner related to interactive whiteboards. Positive attitudes toward interactive whiteboards led to participants using them to project notes onto a screen and adding onto those notes using whiteboards pens. No other common themes were found in which attitudes led the three participants to employing technology.

There were also cases where the participants expressed positive attitudes but did not utilize technology. For this reason, school leaders need to consider additional factors that prevent teachers from using technology. Such factors include a lack of knowledge on how to employ technology, negative attitudes which carry more weight than positive attitudes associated with technology, or perceived barriers which prevent teachers from utilizing technology.

Research has shown that personal experience, vicarious learning, goal setting, and professional development that includes hands-on tasks enhance an individual's self-efficacy with regard to using technology (Mackey & Parkinson, 2010; Morales et al., 2008; Wang et al., 2004). With this being the case, the participants were given the opportunity to express strategies for improving their self-efficacy towards employing graphing calculator projectors, interactive whiteboards, and the Internet for instruction. The interviews revealed that vicarious learning is the main strategy that the participants believed would enhance their self-efficacy regarding the use of graphing calculator projectors. Professional development on advanced concepts was the primary method discussed for improving their self-efficacy towards interactive whiteboards. Finally, both vicarious learning and professional development were the main strategies mentioned for enhancing their self-efficacy associated with utilizing the Internet for instruction. School leaders can consider the participants' recommendations when thinking about ideas that will increase the likelihood of teachers incorporating technology in their schools.

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APPENDIX A

Informed Consent Form

APPENDIX A

Informed Consent Form

Liberty University IRB approval # 812.021910

Principal investigator:
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678-697-9666
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1971 University Blvd
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Institutional Review Board:
Fernando Garzon
IRB Chair
Campus North Suite 2400
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Section I – Description of the Study

The participant understands that this project is being undertaken by Michael Dartt, a doctoral student at Liberty University for the purpose of completing his doctoral dissertation. This study will give the investigator an opportunity to research high school mathematics teachers. The intent of this project is to determine the attitudes of three high school mathematics teachers and whether these attitudes influence the amount of time they spend utilizing technology. All three participants will complete a pre-observational survey, take part in two stimulated recall interviews, and be videotaped teaching six lessons. For the videotaped lessons, three will be announced to the participants ahead of time and three will be unannounced. The participants are not expected to do anything else in this study. All findings will be provided to the participants when the study is completed.

Section II – Risks and Benefits to Students, Teachers, School Staff, and School District

The participant understands that the potential risks to any of the students, teachers, or other school staff at his or her school are minimal, with the greatest risk being a breach of confidentiality. Anonymity will be given to the district, school, and every participant who takes part in the study. Electronic copies of the interview transcriptions will remain on a password protected computer. Audio-tapes, videotapes, or completed surveys will be locked in a filing cabinet until the completion of this project. Upon completing this study, the materials will remain in a locked filing cabinet for at least three years. After the three years have elapsed, the researcher will either continue to keep the materials in the filing cabinet or return them to the participants to dispose of as they wish.

The benefits of participation are that the participant will have a deeper understanding as to whether his or her attitudes influence the amount of time that he or she spends utilizing technology.

The participant understands that if there are any concerns about the risks or benefits of participating in this study, he or she can contact Michael Dartt or the IRB office.

Section III – Costs and Payments to the Participant

The participant understands that he or she will pay no fees for participating in this study. Furthermore, there will be no payments made to him or her for his or her participation in this study.

Section V – Participant's Right to Withdraw from the Study

The participant understands that he or she is free to withdraw from the study at any time without adverse affects or loss of benefits.

Section VI – Right to Terminate Participation

The participant understands that if he or she fails to complete a pre-observational survey, take part in two stimulated recall interviews, or be videotaped teaching six lessons, then he or she can be removed from the study. If the participant is removed, then the investigator may choose a new participant to take part in the project.

Section VII – Voluntary Consent by the Participant

The participant has read the preceding consent form, or it has been read to him or her, and he or she fully understands the contents of this document and voluntarily approves of his or her participation in the research study entitled *The Impact of Teacher Attitudes on Technology Use during Instruction*. All of his or her questions concerning the research have been answered. He or she hereby agrees to participate in this project. If he or she has any questions in the future about this study, then they will be answered by Michael Dartt. A copy of this form has been given to him or her. His or her approval ends at the conclusion of this research project.

Your name below means that you approve of the use of your school for the purposes of this research project:

Consenter's Signature: ___________________________________ Date: _____________

Witness's Signature: _____________________________________ Date: _____________

APPENDIX B

Local School Research Request Form

APPENDIX B

LOCAL SCHOOL RESEARCH REQUEST FORM

Name of School:

Name of Researcher:

Position or Grade:

A. Research Project

a. **Title**:

b. **Statement of Problem and research question:**

c. **Subjects or population for the study**:

d. **Reason for doing this research:**

__________Graduate Study at _____________ University/College

__________Publication/Presentation

__________Other (please specify) _________________________

e. **Dates research will be conducted**: __________

B. All research and researchers must:

a) Protect the rights and welfare of all human subjects
b) Inform students and/or parents that they have the right not to participate in the study
c) Adhere to board policies and applicable laws which govern the privacy and confidentiality of students records

C. This request applies to research conducted within and by local school personnel. All other research requests must be submitted to the Research & Evaluation Office according to the GCPS Research Proposal Format.

D. Principals ONLY need to approve Local School Research Requests. The copy sent to the Research & Evaluation Office is for filing purposes only. No further approval is necessary.

____________________ ________________

Principal's Signature **Date of Approval**

APPENDIX C

Pre-observational Survey

APPENDIX C

Pre-observational Survey

<u>Section I – Background Information</u>

Directions: For questions 1-4, please **circle the letter that best applies**:

1) What is your gender?
   A) Male
   B) Female

2) What is your age range?
   A) Under 20
   B) 20 – 29
   C) 30 – 39
   D) 40 – 49
   E) 50 – 59
   F) 60 – 69
   G) 70 or over

3) How many years have you been teaching?
   earned?
   A) 0 -5 years
   B) 6 – 10 years
   C) 11 – 15 years
   D) 16 – 20 years
   E) 21 – 25 years
   F) 26 – 30 years
   G) Over 30 years

4) What is your highest degree
   A) Bachelors
   B) Masters
   C) Specialists
   D) Doctorate

<u>Section II – Technology Attitudes</u>

Directions for items 5-28: This section is divided into three parts. Each part contains eight attitudinal statements related to a specific form of technology. For each statement, please determine whether you strongly disagree, disagree, agree, or strongly agree.

Part 1: The following attitudinal statements relate to items that can project graphing calculators onto a wall, board, or screen (e.g., Overhead Projector Calculators, TI-Smartview):

	Attitudinal Statement	Strongly Disagree	Disagree	Agree	Strongly Agree
5	They provide students with visual representations that are necessary for student learning				
6	They increase student motivation in mathematics				
7	They increase student enjoyment in mathematics				
8	They encourage interaction between the student and the teacher				
9	They allow students to gain a deeper understanding of course content				
10	They can easily be employed during instruction				
11	They promote laziness in student work				
12	They require substantial preparation time for use				

Do you have any additional attitudes related to items that can project graphing calculators onto a wall, board, or screen (e.g., Overhead Projector Calculators, TI-Smartview)? If so, then please write them in the space below:

Part 2: The following attitudinal statements relate to Interactive Whiteboards (e.g., Smartboards, Promethean Boards):

	Attitudinal Statement	Strongly Disagree	Disagree	Agree	Strongly Agree
13	They provide students with visual representations that are necessary for student learning				
14	They increase student motivation in mathematics				
15	They increase student enjoyment in mathematics				
16	They are helpful when teaching students with different learning styles				
17	They are helpful when teaching students who speak different languages				
18	They allow teachers to enrich their lessons				
19	They are difficult to operate				
20	They require substantial preparation time for use				

Do you have any additional attitudes related to Interactive Whiteboards (e.g., Smartboards, Promethean Boards)?
If so, then please write them in the space below:

Part 3: The following attitudinal statements relate to the Internet:

	Attitudinal Statement	Strongly Disagree	Disagree	Agree	Strongly Agree
21	It enhances student critical thinking skills				
22	It allows teachers to enrich their lessons				
23	It is helpful when introducing a new topic				
24	It increases student motivation in mathematics				
25	It increases student enjoyment in mathematics				
26	It allows students to gain a deeper understanding of course content				
27	It allows teachers to meet the individual needs of more students				
28	It requires substantial time to locate appropriate websites				

Do you have any additional attitudes related to the Internet? If so, then please write them in the space below:

APPENDIX D

Self-Efficacy Interview

Appendix D

Self-Efficacy Interview

1. How would you define "self-confidence" in the context of using technology for instructional purposes?

<u>Graphing Calculator Projectors</u>

2. One a scale of 1 – 4, with 1 being not confident, 2 being somewhat confident, 3 being confident, and 4 being very confident, how would you rate your level of confidence with regard to using a graphing calculator projector as an instructional device? Explain.

3. What strategies are you most confident in using when employing a graphing calculator projector as an instructional device? Why?

4. What strategies are you least confident in using when employing a graphing calculator projector as an instruction device? Why?

5. Have your personal experiences in using graphing calculator projectors made you feel more or less confident in using this technological device? Explain.

6. Have you ever observed another teacher using a graphing calculator projector for instruction? If so, then did these observations give you any more confidence in using graphing calculator projectors? Explain.

7. Have you ever set goals for yourself with regard to integrating a specific instructional strategy when using graphing calculator projectors? Explain.

8. Has anyone assigned to you a specific task (possibly through professional development) where you had to use a graphing calculator projector for instruction? If so, then how did this impact your confidence with regard to this technological device?

<u>Interactive Whiteboards</u>

9. One a scale of 1 – 4, with 1 being not confident, 2 being somewhat confident, 3 being confident, and 4 being very confident, how would you rate your level of confidence with regard to using an interactive whiteboard as an instructional device? Explain.

10. What strategies are you most confident in using when employing an interactive whiteboard as an instructional device? Why?

11. What strategies are you least confident in using when employing an interactive whiteboard as an instruction device? Why?

12. Have your personal experiences in using interactive whiteboards made you feel more or less confident in using this technological device? Explain.

13. Have you ever observed another teacher using an interactive whiteboard for instruction? If so, then did these observations give you any more confidence in using interactive whiteboards? Explain.

14. Have you ever set goals for yourself with regard to integrating a specific instructional strategy when using interactive whiteboards? Explain.

15. Has anyone assigned to you a specific task (possibly through professional development) where you had to use an interactive whiteboard for instruction? If so, then how did this impact your confidence with regard to this technological device?

<u>The Internet</u>

16. One a scale of 1 – 4, with 1 being not confident, 2 being somewhat confident, 3 being confident, and 4 being very confident, how would you rate your level of confidence with regard to using the Internet as an instructional device? Explain.

17. What strategies are you most confident in using when employing the Internet as an instructional device? Why?

18. What strategies are you least confident in using when employing the Internet as an instruction device? Why?

19. Have your personal experiences in using the Internet made you feel more or less confident in using this technological device? Explain.

20. Have you ever observed another teacher using the Internet for instruction? If so, then did these observations give you any more confidence in using the Internet? Explain.

21. Have you ever set goals for yourself with regard to integrating a specific instructional strategy when using the Internet? Explain.

22. Has anyone assigned to you a specific task (possibly through professional development) where you had to use the Internet for instruction? If so, then how did this impact your confidence with regard to this technological device?

<u>Overall</u>

23. What strategies do you feel would be most helpful to you with regard to enhancing your self-confidence in using technology? Are there any strategies that you feel would be more helpful for one of the three technological devices as opposed to another? Explain.

APPENDIX E

Coding Sheet

APPENDIX E

Coding Sheet

Internet Use

A1 – Teacher Accesses Modules to Online Programs

A2 – Teacher Develops Instructional Materials

A3 – Teacher Finds Internet Data

A4 – Teacher Accesses Web-based Lessons

A5 – Teacher Takes Part in Internet Chats

A6 – Teacher Reads Internet Articles

A7 – Teacher Provides Online Tutoring

A8 – Teacher Submits Graded Assignments to Students

A9 – Teacher Posts Questions on the Internet

A10 – Teacher Posts Responses to Internet Posts of Students

A11 – Teacher Accesses Java Applets

A12 – Teacher Accesses Internet Videos

A13 – Teacher Accesses Online Textbooks

A14 – Teacher Conducts Internet Searches

A15 – Teacher Assigns Homework from the Internet

A16 – Teacher Accesses Internet to Show His/Her Blog

A17 – Teacher Accesses Internet to Show Student Blogs

A18 – Students Access Modules to Online Programs

A19 – Students Find Internet Data

A20 – Students Access Web-based Lessons

A21 – Students Explore the Internet

A22 – Students Read Email

A23 – Students Read Internet Articles

A24 – Students Take Part in Internet Chats

A25 – Students Access Online Exams

A26 – Students Submit Assignments to Teacher

A27 – Students Post Responses to Teacher Questions

A28 – Students Post Responses to Internet Posts of Students

A29 – Students Access Java Applets

A30 – Students Access Teacher's Webpage

A31 – Students Take an Online Survey

A32 – Students Work on their Blog

A33 – Students Complete Online Assignments

Graphing Calculator Projectors

B1 – Teacher Models Steps to Solving Problems to Small Groups

B2 – Teacher Models Steps to Solving Problems to Entire Class

B3 – Teacher Uses Calculator to Provide Visual Representations

B4 – Teacher Uses Calculator to Make Predictions

B5 – Teacher Uses Calculator to Provide Generalizations

B6 – Teacher Uses Calculator to Interpret Data

B7 – Teacher Uses Calculator to Find Exact Values

B8 – Teacher Uses Calculator to Check Answers

B9 – Teacher Uses Calculator as an Alternative Means of Solving Problems

B10 – Teacher Uses Calculator as an Expedient Means for Solving Problems

B11 – Teacher Uses Calculator to Lead Students in a Certain Direction

B12 – Teacher Uses Calculator to Stimulate Class Discussion

B13 – Teacher Uses Calculator to Show Common Mistakes Made When Using Graphing Calculators

B14 – Teacher Uses Calculator to Randomly Select Students for an Activity

Interactive Whiteboards

C1 – Teacher Uses Whiteboard to Project Websites

C2 – Teacher Uses Whiteboard to Project Videos

C3 – Teacher Uses Whiteboard to Project Articles

C4 – Teacher Uses Whiteboard to Project Class Handouts

C5 – Teacher Uses Whiteboard to Project Online Textbooks

C6 – Teacher Uses Whiteboard to Animate Objects

C7 – Teacher Uses Whiteboard to Write Class Notes on a Blank Screen

C8 – Teacher Uses Whiteboard to Give Previously Prepared Notes

C9 – Teacher Uses Whiteboard to Review Previously Prepared Notes

C10 – Teacher Uses Whiteboard to Add onto Previously Prepared Notes or Projected Handouts

C11 – Teacher Uses Whiteboard to Give Warm-up Questions

C12 – Teacher Uses Whiteboard to Give Assessments

C13 – Teacher Uses Whiteboard to Give Assignments

C14 – Teacher Uses Whiteboard to Give Instructions

C15 – Teacher Uses Whiteboard to Answer Student Questions

C16 – Teacher Uses Whiteboard to Assign Groups

C17 – Teacher Uses Whiteboard to Stimulate Interactions between Teacher and Students

C18 – Teacher Uses Whiteboard to Stimulate Interactions between Two or More Students

C19 – Teacher Uses Whiteboard to Provide Direct Instruction

C20 – Teacher Uses Whiteboard to Compare and Contrast Items

C21 – Teacher Uses Whiteboard to Play Games

C22 – Teacher Uses Whiteboard to Provide Visual Representations

C23 – Teacher Uses Whiteboard to Give Answers to Homework Assignments

C24 – Teacher Uses Whiteboard to Give Answers to Handouts

C25 – Teacher Uses Whiteboard to Give Answers to Warm-up Problems

C26 – Teacher Uses Whiteboard to Give Answers to Problems During Lessons.

C27 – Teacher Uses Whiteboard to Ask Questions that Introduce a New Topic

C28 – Teacher Uses Whiteboard to Ask Questions in the Middle of Teaching a New Topic

C29 – Teacher Uses Whiteboard to Review Previously Learned Material

C30 – Teacher Uses Whiteboard to Segue into a New Topic

C31 – Teacher Uses Whiteboard to Project His/Her Blog

C32 – Teacher Uses Whiteboard to Project Student Blogs

C33 – Teacher Uses Whiteboard to Ask Questions to Summarize a Lesson

C34 – Teacher Uses Whiteboard to Project Problems for Students to Solve

C35 – Teacher Uses Whiteboard to Set Up a Problem to be Worked by the Class

C36 – Students Come to Whiteboard to Circle Answers

C37 – Students Come to Whiteboard to Underline Answers

C38 – Students Come to Whiteboard to Write Answers

C39 – Students Come to Whiteboard to Play Games

C40 – Students Come to Whiteboard to Give Presentations

APPENDIX F

Classroom Observation Coding Table

APPENDIX F

Classroom Observation Coding Table

Teacher Being Observed: _______________ Date: ____________________

Topic of Lesson: _______________ Length of Entire Lesson: _________________

Type of Observation: Announced/Unannounced Observation Number: 1 2 3 4 5 6

Technology	Code	Time	Code	Time	Code	Time
Internet						
Graphing Calculator						
Interactive Whiteboard						

Additional Notes: