MATH TEACHERS' USAGE OF INTERACTIVE WHITEBOARDS AND INTERWRITE PADS AND THE EFFECT ON STUDENT ACHIEVEMENT IN MATH

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ABSTRACT

The purpose of this correlational-descriptive research study was to determine if the introduction of interactive whiteboards and Interwrite Pads had an effect on student achievement in math [as defined by Missouri Assessment Program (MAP) MAP Test scores) and to establish the strength of relationship between the amount of time math teachers used the technology and student achievement. SJSD math students (n = 1684) were examined over a period of five years.

Three instruments were used in this study: The Technology Usage Survey (TUS), The Follow-up Technology Usage Survey (FTUS), and the MAP. The purpose of the TUS and FTUS was to gather: teacher employment information, level of educational training, the amount of time each teacher used the interactive whiteboard and/or the Interwrite Pad, number of professional development hours each teacher had for using each technology, data pertaining to teachers' perception about using teaching technology to raise student achievement, and teachers' methods for using the interactive whiteboard and Interwrite Pad. MAP Math Test scores were used to measure student achievement.

Test results of this study showed: a significant ($p = .000$) difference in MAP change scores before and after the introduction of interactive whiteboards and Interwrite Pads with change scores prior to the introduction of the treatment being significantly higher. Further tests evidenced mixed results: a significantly ($p = .000$) moderate inverse relationship, as well as, no relationship ($p = .251$) between the amount of time teachers use interactive whiteboards and MAP scores. Final tests evidenced mixed results: a significantly ($p = .000$) moderate positive relationship, no relationship ($p = .142$), and a significantly ($p = .031$) moderate positive relationship between the amount of time teachers use Interwrite Pads and MAP scores.

DEDICATION

I wish to dedicate this paper to my three greatest inspirations: my wife, Dorothy Mae; my son, Gabriel Lee; and my daughter, Julianna Ray. To say their support was important to me during this difficult journey is like saying I needed air to breathe and chocolate to eat. Dot, you are the reason I strive to better every day; your love keeps me sane when nothing else does. Gabriel, you are the strength that keeps me going when I feel like I cannot take another step. Julianna, your smile helps me to laugh and remember what is important in life. Without you three, I would have never reached the dream I have chased so long. All of your sacrifices were so important to me and should not go without acknowledgement. I often feel I am unworthy of such a wonderful family. In short, you all are the reasons I am who I am, just me. You are “she”, “princess”, “mini-me”, and together “we”! Thank you. Love Dr. Dad.

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Chapter One

Introduction and Rationale

In recent years, the amount of money spent on technology in education has climbed dramatically. In "Federal Role Seen Shifting," Andrew Trotters explained that the United States government allocated over $600 million for educational technology in 2005 which, when compared to educational spending in preceding years, was a large increase (1). Trotter stated that over 92% of United States classrooms had Internet access in 2005 as compared to only 3% just ten years earlier (1). Rising technology expenditures have focused not only on computer labs, but also on instructional technology. When used, "technology helps students to better understand material and assists instructors, resulting in more time for other learning activities" (Daniel 1). Trotter and Daniel simply reported what a glance in many public classrooms would confirm: educators constantly push for the introduction and use of classroom technology to help raise student achievement levels. In the last decade, the U.S. educational system moved from buying overhead projectors and chalkboards to purchasing and using computer-aided instruction devices such as Microsoft PowerPoint and multimedia projectors (2). The shift toward more technology-based teaching has continued.

The Missouri public education system followed the country's technology shift from lecture-based overhead projectors to the use of more interactive technology. According to the Missouri Department of Elementary and Secondary Education (DESE), "The Missouri Technology Plan endorses the National Educational Technology Standards (NETS) for students, teachers, and school administrators" ("Census" 1). The NETS Plan outlined the introduction and use of technology in classrooms. Because of this endorsement, Missouri educators began to rely heavily on technological teaching tools. Teachers are not the only individuals who support technology-enhanced teaching. Frey and Birnbaum found students agreed that computer-assisted instruction had an effect on the lectures, especially in helping them take notes and study for exams (1). Today's students expect to be taught with the use of technology. In addition, research has suggested that teachers who took a multimedia approach to instruction were perceived favorably by students, and that this approach yielded significant improvements in student achievement as evidenced by student self-reporting and objective outcome testing (Kashyap 294). Government educational spending habits support the conviction that technology has an effect on student achievement. DESE reported that $108 million were spent on technology for Missouri students in 2005 ("Census" 1), which suggests that DESE is committed to placing technology in Missouri schools. Individual school districts spent an average of $202,025 on technology in 2005 ("Census" 1).

Based on yearly expenditures, DESE appeared financially committed to technology. Was there a relationship between student achievement and the amount of time teachers used the tools? In 2006, President Bush proposed to cut $496 million in technology-grant funding for schools. This sent mixed signals. The U.S. government spent increasingly more money on technology each year, but also looked to cut the same programs it supported. Some U.S. government policymakers believed there was little data to support claims of sufficient improvement in student achievement because of the use of technology. They felt spending educational funds on technology was not warranted. Some government officials called for additional studies with empirical data supporting the effect of technology on student achievement in order to justify spending funds on the introduction of technology into the classroom. Likewise, they required further correlation data supporting a strong relationship between the amount of time specific educational technology was used and student achievement.

The principle function of the current study was to determine both if the use of interactive whiteboards and Interwrite Pads had an effect on student achievement in math and if there was a strong relationship between student achievement and the amount of time math teachers used the technology.

Problem Statement

The Saint Joseph School District (SJSD) continuously explores new ways to strengthen the learning skills of all students. Technological advances in education may be part of the solution to reaching students and raising achievement scores (Ellis 2). Educators believe traditional teaching cannot adequately prepare today's students for today's world. The introduction of specific technology, such as interactive whiteboards and Interwrite Pads, may have an effect on student achievement. As early as 1997, a study revealed that most students do not achieve as well in a traditional environment as they do in a classroom with technology (Hegedu and Kaput 2).

The SJSD continues to allocate more and more funds to the purchase, implementation, and use of technology. Prior to the 2005-06 school year, every math classroom in the SJSD was equipped with interactive whiteboards and Interwrite Pads. The problem this study considered was the effectiveness of this specific technology on student learning in math. Corroboration could be established by providing empirical data that illustrated a significant change in MAP test scores after the introduction of technology, and by establishing the strength of correlation between the amount of time specific technology is used and student achievement in math.

Background

The SJSD is located in Saint Joseph, Missouri (population 77,000+). The urban district, a school district is "an 'urban school district' if it contains all or the greater part of a city with a population in excess of 70,000 persons" ("Missouri H.B. 0050" 1), has three high schools (Benton, Central, and Lafayette) that receive students from four middle schools (Bode, Robidoux, Spring Garden, and Truman). The total student population of the high schools and middle schools (grades 7-12) is about 4600 students annually (Bode: 460, Robidoux: 360, Spring Garden: 450, Truman: 430, Benton HS: 800 students, Lafayette HS: 800 students, Central HS: 1300 students). An average eighth-grade class in the SJSD consists of approximately 900 students who stay together throughout their SJSD high school career (e.g. Class of 2007, 2008, and 2009).

Conceptual Framework

Interactive Whiteboards

According to information gathered in a review of related literature (see Chapter Two), there is a current conviction by educators that the daily use of specific technology, such as interactive whiteboards, can help raise student achievement. "Consumer reports offered praise for introducing such technology [interactive whiteboards] to enhance teaching and learning experiences and to help solve common problems created by old lecture and presentation methods" ("Interactive Whiteboards" 1). Common pedagogy suggests that the introduction and use of interactive whiteboards is not only a good idea for teaching, but also a necessity in the classroom. "Their [interactive whiteboards] functionality was compatible with the desktop machine; however, the size of the display facilitated interactive learning among students and teachers" (Gumibretiere 3). Consumer claims suggested that the interactive whiteboards allow teachers to record their instructions and to post the material for later review by students. According to these testimonials, the visual receptiveness created by using the interactive whiteboard could be a very effective instructional tool ("Interactive" 1). In a 2007 study by Tanner and Jones, researchers found that interactive whiteboards had the potential to affect student achievement in math. Tanner and Jones established that the prospects for learning increased when using technology to teach math (41). Research confirms the interactive whiteboard as an effective teaching tool.

Interwrite Pads

Based on information collected from related research studies (see Chapter Two), teachers believe that student achievement could be improved through the introduction of Interwrite Pads. Based on individual studies of the Interwrite Pads, this technology has the potential for raising student scores. "InterWrite Pad was designed with the teacher in mind. This Bluetooth™ wireless pad includes Interwrite Software and gives the teacher the ability to teach their interactive lessons from anywhere in the classroom" ("Interwrite Learning").

Most of the documented results for Interwrite Pads comes from manufacturers' (Interwrite Learning and Solutions) testimonials or from companies trying to sell the pads. Little empirical data exists to support or to refute their claims. However, a few independent studies focused on wireless student devices, such as the Interwrite Pads. Results from a University of Strathclyde case study provided statistical data to support the need for Interwrite Pads. This study was propelled by an initiative by the University of Strathclyde to install Interwrite Pads into four main lecture halls (with a capacity of up to 150 students each) in order to help increase student participation and information retention during lectures. Based on student surveys, the researchers found that “over 90% of students felt that concepts were learned more effectively” when using Interwrite technology (“Innovative Learning” 1).

Educators continue to support the notion that the use of such devices benefits students. “InterWrite SchoolPads have made students excited about learning. With the touch of an electronic pen to the screen, students are using their skills in new ways, making learning more authentic and fun. The InterWrite SchoolPads have become an essential part of our classrooms” (Truman, “Interwrite SchoolPads” 1). Educators stated that combining the use of the interactive whiteboard and the wireless Interwrite Pad gave the teacher and student total mobility and actually helped increase teaching effectiveness by enabling up to seven users to interact with a presentation simultaneously. This allowed students to engage actively in a project while the teacher remained in control of the classroom and learning (Hastings 1).

Testimonials and limited empirical data alone are not enough to justify the purchase of interactive whiteboards and Interwrite Pads. In order to warrant purchase, data from studies, such as this one, must support the declared effect of the technologies on student learning.

Amount of Time Math Teachers Use Technology

Studies indicated that not only does the use of technological teaching tools, such as interactive whiteboards and Interwrite Pads, raise student achievement but also the frequency/duration with which they are used could affect student learning (Hasting 1). In order to validate any findings about technology use, the strength of correlation between the amount of time math teachers use both the interactive whiteboards and Interwrite Pads and student achievement needs to be established. In his 2003 dissertation, Ury studied the way educational administrators monitored and assessed teachers' use of technology. He suggested, "Pressure is being exerted on our K-12 educational system to prepare students for technological challenges in the 21st Century" (108). Teachers are being required to spend greater amounts of time using technology to educate students. Thus, one crux of this current study was providing data that might establish how much instructional time is needed to raise student achievement. The shift from the overhead projector teaching style to the daily use of the interactive whiteboard and Interwrite Pads was meant to help raise student achievement (Hasting 1). Hence, an additional focus of this study was to determine the strength of the relationship between student achievement and the quantity of time teachers used the interactive whiteboards and Interwrite Pads.

Purpose and Significance

The purpose of this correlational-descriptive research study was to determine if the introduction of interactive whiteboards and Interwrite Pads had an effect on student achievement in math (as defined by Math MAP scores) and to establish the strength of relationship between the amount of time math teachers used the technology (as defined by the Technology Usage Surveys) and student achievement. This study has the potential to be a resource to educators in SJSD as they discuss the merits of investing in interactive whiteboards and Interwrite Pads. The results of this study add to the growing data pertaining to educational teaching technology and have the potential to change the way in which the SJSD uses such technology.

Delimitations

The researcher set several delimitations, controllable factors that may or will affect the study (Mauch and Birch 103), that may have an impact on the ability to generalize the results of this study. The following delimitations were part of the design of this study.

This study has four delimitations that will potentially affect the generalization of the results: a) only two types of teaching technology were considered; b) mathematics was the only academic area explored; c) the sample group for this study came from only one midwestern, urban school district; and d) the sample groups for this study were selected from only middle- and high-school students.

Assumptions

In research of this nature, certain assumptions must be made. For the purpose of this study, two primary assumptions were made. The first assumption was that teachers' responses to the surveys accurately reflected their professional opinions. The second assumption was that the sample was representative of all math teachers and math students in the SJSD.

Research Questions

This study explored three research questions:

1. What is the effect of the introduction of interactive whiteboards and Interwrite Pads on student achievement?
2. What is the strength of the relationship between the amount of time math teachers use interactive whiteboards and student achievement?
3. What is the strength of the relationship between the amount of time math teachers use the Interwrite Pads and student achievement?

These questions provided focus, gave cohesion, guided analysis, and dictated interpretations for this clinical research study.

Definitions of Key Terms

Certain key terms were used throughout the study. The following definitions and explanations were associated with the use of those terms.

Control test group. Name given to the SJSD class of 2007 from which test scores were taken prior to the introduction of the technology.

Interactive whiteboard (also labeled electronic whiteboard). "The three basic elements are:

1. either the humble whiteboard or a specially-designed whiteboard,
2. the computer, and
3. a digital projector linked to the computer.

Images are projected onto the whiteboard and teachers or students can add to them using whiteboard pens or, if the screen is touch sensitive, by touching the screen. To these elements can be added:

1. specialist teaching software, electronic resources on CD-ROM or from the Internet,
2. an electronic pen that takes the place of chalk or the whiteboard pen for writing over the projected images,
3. a ‘flipchart’ capability to save and print the images, use them with other applications such as a word processor, or post them to a website” (Bell v).

Interwrite Pads. “Interwrite Learning’s Interwrite Pad was designed with the teacher in mind. This Bluetooth™ wireless pad includes Interwrite Software and gives the teacher the ability to teach their interactive lessons from anywhere in the classroom. The Interwrite Pad revolutionizes how teachers interact with their class” (“Interwrite” 1).

Missouri Assessment Program (MAP). “Performance-based test administered to Missouri public school students designed to measure student progress toward meeting the Show-Me Standards. Created because of the passage of the Outstanding School Act of 1993, the assessment measures what students know as well as what they can do. This Assessment was the successor to the MMAT” (“Assessment” 1).

Primary test groups. Name given to test groups—the SJSD class of 2008 or class of 2009—from which test scores were taken prior to and after the introduction of technology.

Overview of Methodology

Introduction of Technology

The research design for this case study was correlational-descriptive research. From the SJSD Classes of 2008 and 2009, two primary sample test groups were selected because the specific technology was introduced between both classes’ eighth-grade and tenth-grade Math MAP testing times. A control sample group was selected from the class of 2007 because the specific technology was introduced after this class's Math MAP test times (see Table 1, below). All three classes were used to test the hypotheses.

Table 1

Study Timeline

				Introduction of Technology	
Year:	2002-2003	2003-2004	2004-2005	2005-2006	2006-2007
Class of 2007	8th Grade MAP Test	9th Grade No Data	10th Grade MAP Test		
Class of 2008		8th Grade MAP Test	9th Grade. No Data	10th Grade MAP Test	
Class of 2009			8th Grade MAP Test	9th Grade No Data	10th Grade MAP Test

Math MAP scores (eighth-grade and-tenth-grade) were gathered for all students within the test groups prior to and after introduction of the technology. The control group's Math MAP tests were given before introduction of the technology.

Amount of Time Math Teachers Use Technology

All SJSD middle and high school math teachers were asked to complete the Technology Usage Survey TUS and Follow-up Technology Usage Survey (FTUS). The duration of both the TUS (see Appendix F) and the FTUS (see Appendix G) was 14 days. These surveys were created to collect general teacher information and the time of use of the interactive whiteboard and Interwrite Pads.

Organization of Clinical Research Study

The remainder of this study is organized into four chapters. Chapter Two explores past and current research linked to the primary Critical Research Study components, including an examination of: (a) technology used as an effective teaching tool in math, (b) interactive whiteboards used as an effective teaching tool, (c) Interwrite Pads used as effective teaching tools, (d) the relationship between the amount of time teaching technology is used and student achievement, and (e) the use of MAP scores as a valid measurement of student achievement. Chapter Three defines the research methodology for this study, including population and sample, instruments of analysis, and method for hypotheses testing. Chapter Four discusses the results of the study, including organizing the results, methodology summary, population sample and participants, results, and summary of results. Chapter Five contains the interpretations of and recommendations for the study: (a) a summary of the results, (b) a discussion of the results, (c) a summary statement, (d) implications for further research, (e) implications for practice and recommendations, (f) relationship of the results to theory, and (g) a summary and conclusion. The study concludes with works cited and appendices.

Chapter Two:

Review of the Literature

The following review of selected literature focuses on six major educational underpinnings:

1. studies that focused on technology used to raise student achievement,
2. research that centered on technology used to raise student math achievement,
3. literature that assessed interactive whiteboards in the classroom and their effect on student learning,
4. studies and testimonials that focused on Interwrite Pads in the classroom and their effect on student achievement,
5. documentation that addressed the relationship between the amount of time math teachers used technology and student achievement, and
6. studies that involved the use of Math MAP Scores as a valid assessment tool.

Data and findings gathered during the review of literature were used to support the six major underpinnings of this study.

In 1985, software companies introduced the use of spreadsheets in electronic presentations. Next, early Lotus 1-2-3 versions included presentation features that allowed for basic electronic slides. Educators, intrigued by the use of electronic presentation software, began to demand enhanced visual presentation options in order to reach students better. By 1988, several presentation graphics packages, like PowerPoint, were available, and were beginning to be used more often in classrooms. “Features included the ability to import a wide variety of numeric data, improved charts and graphs, upgraded and bulleted text, dynamic links between spreadsheets and graphs, and use superior color backgrounds. The output quality also improved and prices began to drop" (Strasser 1). Although little empirical data existed to support the use of technology to improve student achievement, as technology became more affordable for school districts, the purchase of computer-aided teaching tools began to rise dramatically.

A typical trend in the world of education is that of school districts following practices and protocols set by the business sector. The use of technology in and out of U.S. classrooms and boardrooms has risen dramatically in the last few decades. In fact, in the ten years from 1985-1995, the amount of technology used daily in businesses grew exponentially (Strasser 1). As the 1990s were ending, most businesses were working to improve their presentation hardware and software, and school districts across the U.S. followed suit. From the 1980s through the first years of the new millennium, the implementation of educational technology grew quickly, but little focus has been given to the collection of data, which might support such use. "Teachers now need to learn how to use new technology in creative and effective lessons which engage students" (Vojtek and Vojtek 14). The demand for educators to teach with computer-enhanced instruction has grown stronger since Strasser's 1996 report.

As happened in business, the access and use of technology by students has climbed dramatically since the late 1980s. "Since the early 1990s, increasing student access to high-end technology has become a national priority, underscored by Presidents [sic], Presidential [sic] candidates, governors, state legislatures, and corporate leaders" (Cuban, Peck, and Kirkpatrick "Techno-Promoter" 1). Educators and policy makers alike, including those in Missouri, have made the purchase of technology a priority in their fight to raise scores on standardized tests, such as the MAP Test. Responding to this call for technological excellence and standardized test score improvement, schools had dramatically lowered their student-to-computer ratios (Cuban, Peck, and Kirkpatrick 1). For over two decades, educators have sought to supplant common lecture-style instruction with new, modern, and computer-enhanced teaching methods that they believe will help raise student achievement. Educational theory purports that the use, for a set amount of time, of specific technologies such as interactive whiteboards and Interwrite Pads, will result in improvement of students' standardized test scores. The remainder of Chapter 2 is devoted to reviewing literature that might support or refute such a theory.

Educational Underpinnings

To better understand the possible impact of interactive whiteboards & Interwrite Pads on student achievement in math (Math MAP) scores, as well as to begin discovering the impact of the time of technology use on student achievement, the following educational underpinnings were explored:

1. Technology Used to Raise Student Achievement
2. Technology Used to Raise Student Achievement in Math
3. Interactive Whiteboards in the Classroom
4. Interwrite Pads in the Classroom
5. Amount of Time Math Teachers Use Technology
6. Math MAP scores as a Valid Assessment Tool

Technology Used to Raise Student Achievement

Teaching Technology In General: For decades, technology has been used as a way to raise student achievement. Dr. Larry Cuban, writer, researcher, professor of education at Stanford University, and expert on technology in schools, supported this claim repeatedly. Dr. Cuban consistently confirmed that many educators believed that technology was needed in the classroom. As proof, he noted a rise in total technology purchases in school districts during the 1980s and 1990s. Estimations of computers to students ratios decreased from 92 students per computer in the 1983-84 school year to 27 students per computer in 1988-1999, and to less than six students to computers in 1999-2000 (Cuban, Peck, and Kirkpatrick 4). Essentially, in less than two decades, the student-to-computer ratio decreased 86%. This technology trend was experienced in most school districts. In 2003, the estimated student-to-computer ratio for Missouri was 3.3 and that in SJSD, 2.5 (“2000 Census”). Both the state and the school district used in this study follow the national teaching technology trend. “The increase in high-tech access represents a staggering national financial investment in school technology over the last fifteen years” (Cuban 4). Cuban and his colleagues pointed out that the U.S. educational system supports the use of technology as a means for raising student achievement. However, the researchers agreed that additional studies are needed to validate continuously the purchase of technology. “Research that explores the effectiveness of instructional methods using technology and also evaluates equipment and programs used for teaching can indicate the direction for future use of hardware, software, and teaching practices” (Vojtek and Vojtek 16). As Cuban stated, and Vojtek and Vojtek directly supported, current research studies may provide empirical data to support spending on educational technology as well as help direct the implementation of such equipment in educational practices. Studies that focus on the effectiveness of technological teaching, such as this study, are important and needed to support or refute statistically the need for technology in the classroom.

Scott DeWitt’s dissertation focused on four social studies teachers who effectively used technology. DeWitt examined student motivation, visual images, and efficiency. He found that, when teachers used technology to communicate material, they created a hybrid instructional style (direct instruction supported by technological visual teaching techniques). DeWitt found that the hybrid style improved students’ level of information acquisition and retention. His findings thus strongly support the use of technology as an effective teaching tool.

The National Center for Education Statistics reported that “in the year 2001, 99% of public schools and 87% of instructional rooms in the United States had access to the Internet, up from the 1994 levels of 35% and 3% respectively” (“Internet Access” 6). If a snapshot of a teacher lecturing in a 1970s classroom was compared to a picture of that same room 39 years later, a primary difference would be use of technology. It is likely that a multimedia projector would be hanging from the ceiling and at least one computer would be present in the more recent photo. The presence of so much technology in current classrooms reinforces a commonly held view: American education is technology, and technology is education. Not only do school districts expect teachers to use technology, they demand it. This demand is affirmed mainly by the amount of money spent each year on computer apparatuses and the amount of technology installed into American classrooms each year. The implied intent of this technology is that it will be used to teach daily (DeWitt 2). In short, educators believe what studies such as Cuban’s, Vojtek and Vojtek's , and DeWitt's reported: the introduction and use of technology in a classroom can have an effect on student achievement in general.

Teachers use technology to mark student attendance, draft documents, prepare lesson plans, project daily academic information, provide student-to-computer-to-teacher interfaces, and to acquire real-time, computer-generated student feedback. Teachers rely on and accept that "a technology-rich, learner-focused environment is essential for all students to be prepared for 21^{st} century life" (Morrison and Warren 2). It may be hypothesized that the use of technology to influence student learning is of the utmost importance to school districts across the country. The U.S. government spent an estimated $7.8 billion on technology in 1998 (Anderson and Becker 1). Since then, monies spent on technology in public education have grown exponentially.

Educators and Teaching Technology: Many educators feel that computers-aided teaching is an excellent way to reach students. "Computers are seen as a catalyst for change in education" (Sandholtz, Ringstaff, and Dwyer 2). Several study results documented teachers' positive feelings about technology as a tool to affect student achievement. In "Computer Based Technology and Learning," Valdez discussed the overall importance of technology and its effect on achievement. The pervasive perception among teachers is that student achievement will be improved simply by having computers in the schools (Valdez 27). Valdez contended that with a technologically improved learning climate came an increase in student motivation in subjects for which teachers used computers to instruct. He proposed that the cognitive processes involved in learning would be improved by the mere presence of technology in a classroom (27). Motivated students tended to learn at a higher rate. Valdez claimed that technological teaching aids helped with inspiration. His findings, like those of previously documented researchers, provided additional support for technology's positive effect on student achievement.

As previously stated, the SJSD has followed the technology-in-education trend. As with other school districts, SJSD educators support technology use as important to student learning:

> The School District of St. Joseph recognizes the educational and professional value of electronics-based information technology, both as a means of access to enriching information and as a tool to develop skills that students need. The district's technology exists for the purpose of maximizing the educational opportunities and achievement of district students. ("SJSD Technology Usage")

Thus, by their own testimonials, the SJSD educators support the use of technology to help raise student achievement. "Computer-assisted instructional software applied to prescribed tasks can raise test scores over a period of time" (Cuban, Peck, and Kirkpatrick "Spending" 1). Although studies revealed significant effects of technology use on student achievement, Cuban and associates also maintained that most educators are not tapping the true potential of educational applications: "Though there is some data to support the spending of taxpayers' money on educational technology, further information is needed" (Cuban "Spending" 2). While research supports the possibility of technology's positive effect, Cuban and others suggested that educators need to continue to research the subject and noted a needed for further studies, such as this one, to help validate the importance of technology in teaching.

Technology Used to Raise Student Math Achievement

Dr. Rita Lindsay studied six college algebra classes at a local community college. Three classes were taught in a traditional manner, and the others were taught with computer aids. Lindsay found that there was some potential for raising student math scores through technology-based education (iv). Data from her study revealed that technology has the potential to be a statistically significant factor for raising achievement in math classes (3). Though the results of Lindsay's study supported the use of technology in the classroom, she, like Cuban, indicated that additional studies were needed for complete validation of using technology in teaching math.

Results of a 1991 National Research Council study acknowledged that, of all the influences on math education, technology had the greatest potential to impact student achievement ("Moving Beyond" 1). The council, therefore, supported the idea that math achievement can be affected positively by technological teaching methods. Findings of a 1992 study at a large, midwestern state university, which evaluated the use of the computer as a demonstration aid in college intermediate algebra classes, revealed that through the use of classroom technology, students developed confidence in completing arithmetic problems and developed a greater motivation to do mathematics (Gangui 611).

In a 1991 report, researchers Plomp, Pilon, and Reinen explored the use of computers as a learning aid versus the use of computers by instructors as a teaching aid at the University of Botswana. This study demonstrated that students using Mathematics and Science Computer Assisted Remedial Teaching (MASCART) showed statistically significant increases over the control group from pre-test to post-test scores (37). Research data supported that the use of technology helped to develop student cognition and, thus, helped raise test scores. In a similar 1999 study, which focused on the impact of an integrated learning system on the mathematical skills of first-year high school students, researchers reported significant differences in performance on the end-of-year mathematics exam for students who had used and were taught using mathematical technology (Taylor iv). In her dissertation, Patricia Huber examined the effect of technology use on math instruction. Her work explored possible factors affecting student retention and academic success in Algebra I. Huber provided ample evidence that technology positively affected achievement in math courses. Evidence on the impact of computer-assisted instruction suggested electronic instruction for mathematics students might strengthen the learning process, student cognition, and student achievement (Huber 37). Huber made a strong case for the introduction and use of technology and its effect on student achievement in math.

In a 2004 study of sixth-grade students and technology education, researchers reported:

> A total of 17 students with disabilities and 76 students without disabilities were taught using either enhanced anchored instruction (EAI) or text-based instruction coupled with applied problems (TBI). Results showed that both EAI and TBI students benefited from instruction in their math class, but EAI students were able to maintain and transfer what they learned in the technology education classroom. (Bottge et al.)

Unlike other studies, which only explored display technology, Bottge researched technology that was used to display information as well as to act as an interactive, hands-on, teaching tool. Bottge's results revealed that display technology (electronic whiteboards) as well as interactive technology (e.g. Interwrite Pads) helped students to perform at a higher level in math.

In 2007, the U.S. Congress passed a Competitiveness Bill to "bolster mathematics and science education through improved teacher recruitment and training and [to] promote successful classroom practices through federal grants. This bill was estimated to cost $43.3 billion over three years" (Cavanagh). Based on the passage of such legislation, the U.S. government continues to support the use of technology in the classroom. With findings of Lindsay, Gangui, Bottge et al., Cavanagh, and others, authentication of such funds appropriations seems justifiable. However, researchers must hypothesize as to which specific display hardware and/or hands-on media is best suited to help students.

Interactive Whiteboards in the Classroom

Interactive whiteboards are described as the combination of the common whiteboard with multimedia projectors. As items are projected onto the board, students can manipulated the images by adding additional items via electronic pens or even their own hands (Bell 1). Students learned concepts faster or retained a higher percentage of material when the information was presented graphically (Shelly et al. 2). Visual input was the foundation of student cognition. As cited, research by authors such as Lindsay, Bottege, and Bell supported the idea that learners retained information more readily from educational technology in general. As to the interactive whiteboard:

> According to a report on the impact of information and communication technology (ICT) by European Schoolnet (EUN), a partnership of 28 education ministries from across Europe, interactive whiteboards aid

> student achievement. The findings, largely based on studies conducted in the UK, established that using whiteboards creates a faster pace in the classroom, enhancing interaction between teachers and students. The result? Improved test scores, especially in English, Math, and Science, when compared to student performance without interactive whiteboards. ("Whiteboards" 1)

Claims by organizations such as European Schoolnet support the interactive whiteboard as being specifically important to raising student achievement in many disciplines, including math.

In her dissertation, Mary Bell explored the use of interactive whiteboards and their effect on achievement in a Texas junior high school. Bell studied 90 students instructed by one Language Arts teacher. The teacher taught a control group of students using traditional lecture-based practice, while a test group was instructed using an interactive whiteboard. Bell's study concluded that the interactive whiteboard could easily be used to engage students visually in the lesson. The interactive whiteboard, Bell surmised, was a valuable tool in an interactive learning environment because students actively participate in these lessons by relating to the teacher by means of the whiteboard (27). The primary difference between traditional boards, used simply for display purposes, and the interactive whiteboard lies in the interactive capability of the whiteboard.

> An instructor can use an electronic pen that takes the place of chalk or the whiteboard pen for writing over the projected images, and a 'flipchart' capability to save and print the images, and use them with other

> applications such as a word processor or post them to a web site so that the class has a record of the lesson (Bell 2).

The fact that teachers are beginning to use interactive whiteboards in daily instruction is observable: “Teachers are exhibiting particular interest in presentation devices and systems, which allow computers to be used for group instruction” (“Devices” 1). Though not all research questions in Bell’s study yielded significant change, one test affirmed a raise in scores and another confirmed that “test group students [those taught with interactive whiteboards] showed consistent gains when compared to control group students” (Bell 2). Data from research studies, such as Bell’s, support interactive whiteboards as being effective tools for raising student achievement.

Research that explored the effectiveness of technological instructional methods and evaluated the specific equipment and programs used for such teaching indicated a need for the future use of technological hardware, software, and teaching practices (Vojtek and Vojtek, 1998). Such research, as prefaced by Vojtek, was meant to help sustain belief in the potential importance of visual teaching display technology, such as the interactive whiteboard. In a 1995 study that focused specifically on the interactive whiteboard, researchers concluded that the board offered unique qualities that merited additional study (Sugar and Boling 1). If interactive whiteboards do have unique educational qualities (providing hands-on daily visual aid for the projection of classroom knowledge), does the implementation of such features sufficiently help raise student achievement?

In his dissertation, Kulwadee Kongrith explored the effectiveness of technology on discussion duration and knowledge recall. This study explored student participation in class discussion and student ability to retain and recall information from classes taught with traditional lecture methods (no visual aids) versus PowerPoint presentations. The results suggested that, to raise student achievement, teachers must do more than simply present information to students (Kongrith 1). Introducing technology did little if teachers did not use it and use it effectively. “It is necessary for instructors to realize that teaching is not just presenting content to students, but should foster students’ connections to content as well” (Mason and Hiynka 1). Kongrith suggested that teachers must learn to use various methods of instruction that help strengthen student cognition by providing information in a tangible way (ii). According to Kongrith, educators needed to realize the importance of the introduction and use of specific technology, such as interactive whiteboards, to strengthen retention, cognition, and application skills. In the end, Kongrith found that the method of material presentation did, in part, affect instructor/student verbal interaction in a classroom (ii) and that students learned best when they were actively constructing new knowledge rather than passively acquiring information (Maddox, Johnson, and Willis 12). Presentation technology is essential in catching a student’s attention, and the use of visual technology, such as the interactive whiteboard, can positively affect student achievement. The applications (interactive whiteboards) helped to control information delivered to the students and keep them actively and intellectually involved in the lesson (Maddux, Johnson, and Willis l3). Thus, the learners were directly engaged in learning and the potential for student achievement was improved. “Presentation technology has the potential to stimulate active intellectual involvement and provided opportunities for spontaneous and open-ended verbal interaction” (Maddox, Johnson, and Willis 5). Students not only liked information delivered via technology but also, essentially, needed interactive technology, such as interactive whiteboards, in order to learn. If so, does the use of the interactive whiteboard greatly affect student scores on a standardized assessment, such as, the Math MAP Test?

Peter Kent explored the effects of the interactive whiteboard on today's math learner. Kent studied schools in Australia that used ETeaching (use of any electronic device to enhance an educational lesson) to strengthen math skills. He found that, "learning to justify mathematical claims deductively remains a challenge especially for the high school student" (vii), but he suggested that technology could ultimately help to raise student achievement in math classes and that specific technology, such as interactive whiteboards, could have a direct effect on mathematical success. If interactive visual technology is effective in raising student achievement, is hands-on student response hardware, such as the Interwrite Pad, equally effective?

Interwrite Pads in the Classroom

With regard to teaching technology research, especially that of the Interactive Pads, few studies and relatively little data exist (Swan et al. 1). Due to the Interwrite Pad's newness, most information on it is based primarily on testimonials distributed by the pad's manufacturer. Claims made, and testimonials recorded, by Interwrite Learning and Solutions may have statistical backing, but are also advertisement for the product. According to Interwrite Learning and Solutions, Interwrite Pads were designed to connect with students in an interactive manner. "The Interwrite Pad revolutionizes how teachers interact with their class" ("Interwrite" 1). To state that anything, much less a form of teaching technology, revolutionized teaching is a claim that needs to be backed up by years of empirical data. Since the Interwrite Pad's introduction into the educational environment is recent, it is necessary that studies, such as this one, be conducted to justify such a declaration about its place in the classroom.

In an external study, researchers explored how the use of technology supported whole-class engagement. This "mixed methods case study was to explore the effects of technologies designed for whole class use on third grade students' engagement in learning activities" (Swan et al. 4). Lesson materials utilizing technology were delivered to a single third-grade classroom in northeast Ohio. "Data sources included structured classroom observations, student self-reports, teacher interviews and student focus groups. Quantitative data was compared among lessons grouped by technologies employed using analysis of variance, and significant differences between groups were revealed" (4). Significant differences were found in the results of the test groups. "Post hoc analysis of the student ratings found significant differences in engagement between lessons employing the student response system and all but those employing the wireless writing pads (although these approached significance), providing support for the observational findings" (4). Results indicated a greater observed engagement when technology was introduced and used. "The quantitative results suggest that whole class engagement can be increased by technologies that afford greater participation of all students" (13). Though this study did not involve Interwrite Pads specifically, the foundation of need for such technology was set. The inference could then be made that technologies, such as the technology in this study, could have a positive effect on student achievement. In order to make claims for Interwrite Pads, additional research was explored.

According to Interwrite Learning and Solutions, Interwrite Pads offer benefits for education in general:

1. “Ideal as stand-alone units for a district or school math program” (*Explanation: The Interwrite Pads can work without direct computer hookup; they can be plugged directly into a multimedia projector.*)
2. “Complementing any pre-existing math program” (*Explanation: The Interwrite Pads can be used as supplemental technology or as a leading teaching tool.*)
3. “Flexibility to differentiate instruction among a diverse range of learners” (*Explanation: The Interwrite Pads can be used with any subject at any level of education*.)
4. “Motivating and stimulating new learning if courseware is used for lesson starters” (*Explanation: The Interwrite Pads allow the teacher and student a chance to have hands-on learning experiences*.)
5. “Enhancing mid-topic study through exposure to additional explanations and strategies” (*Explanation: The Interwrite Pads can be used as an instrument to supplement additional information, pictures, etc. into the middle of an existing lesson*.)
6. “Providing review and extension opportunities when used as a unit summary piece” (*Explanation: The Interwrite Pads can be used as a review tool, providing instant student feedback to the teacher*.)
7. “Offering supplemental classroom instruction that targets the needs of struggling or accelerated learners” (“Interwrite Pad” 1) (*Explanation: The Interwrite Pads can be used to assist in visually teaching students who are struggling or visually challenging advanced students*.)

By Interwrite’s testament, the pad is very effective in educational settings. However, to support this claim, additional studies were explored.

Anastasia Trueman, technology researcher and writer, conducted a small study with the newly purchased Interwrite Pads in her own school. After gathering data pertaining to the use of Interwrite Pads in all core subject areas, Trueman found, “wireless pad gives teachers the ability to use an electronic pen like a mouse to annotate and highlight any computer image. It also enables teachers to interact with a projected image at the front of the room while standing anywhere in the classroom” (1). Trueman gathered additional teacher input to validate her claims. She quoted a particular teacher in her study: "I try to find exciting ways to help students learn. I became interested in electronic whiteboards after seeing them at a conference. I was curious as to what they could do and how I could use them in the classroom" (2). Individual claims supported the idea that the Interwrite Pad was an effective teaching tool for helping students to learn actively. Active learning is commonly believed by educators to be the best way to instill new information, as well as the best avenue for producing original thought in any classroom. Teachers want to move past passive learning and use more active learning instruction models to engage students better in the learning process (Fink). The Model of Active Learning is built upon the theory that students who had dialogues with themselves and others, and then participated in related practical, hands-on activities, learn the material more efficiently than those who did not. Trueman provided further educator testimonials supporting the Interwrite Pad as an effective tool in developing active learning skills:

> I have used the SchoolPad in several different curricular areas. Students have used the SchoolPads in math class to answer questions, which can be posted on the computer and TV. Students also have the capability to quickly answer questions, post new questions, and challenge each other using the pads to race in math drills. In addition, the SchoolPad was helpful when teaching fractions because they could be easily drawn and represented with concrete models on the screen to help students understand the lesson and start applying the knowledge on their own. ("Interwrite SchoolPad" 1)

Such testimonials provide some evidence of the effectiveness of the Interwrite Pad; however, is the device effective within specific disciplines, such as mathematics?

Interwrite Pads are billed as potential conduits for developing student cognition skills in math. "MathMastery curriculum, available in English and Spanish, includes core concepts in math, from addition to equations, roots to exponents, and covers the needs of students from grades two through eight. These scientifically proven programs have been recognized by the U.S. Department of Education for their excellence" ("Interwrite" 1). Such information continued to support claims that the introduction and use of Interwrite Pads could be beneficial in raising student achievement in all subjects. The Dare County Schools published findings from their own study of interactive whiteboards/Interwrite Pads and the effect on students' math achievement. According to the report, "Flight High School math teacher, Beryl Iven, is loving the technology she has available in her classroom, and has found [a] myriad [of] ways to use the tools [interactive whiteboards and Interwrite Pads] at hand to augment her instruction of pre-calculus and BC Calculus this semester, adding Advanced Functions and Modeling second semester" (Interwrite Online). Using Interwrite Pads, Iven's students were able to participate interactively in lessons. Iven commented that, with the Bluetooth technology, she could control the School Pads (Interwrite Pads) and laptop from anywhere in the classroom. The school Pads could be passed from student to student. "I no longer have to stand in the student's line of sight as I had to when limited to using the overhead projector" ("Interwrite" 1). Though Ms. Iven's testimonial is cited by Interwrite Learning and Solutions, the information came from a practicing teacher who conducted her own study. The usability of the instrument seemed to be verified, at least from the manufacturer's point of view.

Further data was required to support the Interwrite Pad as being a valid instructional instrument.

Specific statistical analysis of the effectiveness of the Interwrite Pad was explored in a 2003 study entitled, “Wireless and Mobile Technologies to Enhance Teaching and Learning.” The Lui Research Study looked into the possibility of building a wireless classroom that worked in everyday, real world classrooms using such teaching technologies as interactive whiteboards and Interwrite Pads. The wireless classroom that researchers designed was called WiTech. The instruction centered on direct interaction between the questions the teachers posed and the responses given by the 90 third through sixth grade students who participated in the study. The study revealed that the use of wireless Interwrite Pads and interactive whiteboards:

1. reduced the time for task keeping and general classroom records or other tedious work (since attendance and participation were computer-tallied),
2. helped engage all students in activities because the teacher could easily monitor student responses and participation,
3. facilitated group learning,
4. saved time by recording student work and quiz scores automatically in the electronic gradebook program (Lui et al. 371).

This study certainly supported the theory that both the interactive whiteboard and Interwrite Pad could have an effect on student achievement, as long as certain factors were in place (i.e. teacher preparedness, system familiarity, topic compatibility, etc.). These results, beyond testimonials, were among the first to provide statistical data supporting the use of Interwrite Pads. However, the question becomes, if the use of both the interactive whiteboard and Interwrite Pads can be effective, is there a relationship between the amount of time they are used and student achievement?

Amount of Time Math Teachers Use Technology

Results of Hope's 1996 study revealed that, though computer technology was gaining rapid acceptance and use in schools, educators still needed to be convinced of its value and trained in the use of new devices and applications (4). Though technology is available in almost every classroom in America, individual teachers must actually use the technology in order to explore its effectiveness on student achievement. Ury's study supported the conviction that technology, when used continuously, could be an effective tool for raising student achievement (iv), thus supporting the idea that the amount of time teachers use technology is as important as the technology itself.

"Educational Testing Service showed that technology can help raise student achievement if it is used for learning simulations and applications" (Wisniewski 23). Wisniewski suggested that there was, indeed, a strong relationship between the use of technology and improved student achievement, but that teachers must use such equipment often to gain real results. "In interviews, students reported little to no use of computers in the vast majority of their academic classes, though they did mention that many instructors occasionally used VCRs (and, in math, graphing calculators) and frequently used overhead projectors. Moreover, in schoolwide student surveys we conducted, students reported a modicum of computer use in English and social studies, but negligible to absolutely no use in math, science, and foreign language." (Cuban "Techno"). Cuban suggested that, in some fashion or another, our school systems would have to become more technology-driven to compete in the global market. He continued that, even though technology may be available, teachers are slow to use the equipment in their daily teaching. Thus, the amount of time teachers actually use technology to teach becomes a focal point of this study. Cuban supported the notion that technology could be effective when used for the appropriate amount of time. In his 1995 study of Silicon Valley High School students, he found: "Certain teachers had adopted different technologies to enhance their teaching and by extension that students in those classes received at least some exposure to technology had the potential to benefit academically" (Cuban "How Teachers"). Cuban reported that teachers in the test group had accepted the growing educational theory that more exposure to technology would ultimately lead to an increase in student achievement. However, with regard to actual time teachers used technology, he found: "Teacher use of technology during our random observations was the exception rather than the rule" ("How Teachers" 1). Teachers in his study rarely used the equipment for teaching. Thus, though money for technology was being spent and research suggested that using technology to teach would help improve student achievement, not all teachers were willing to use the technology.

Funds being spent by school districts, such as the SJSD, on educational technology are being looked at more closely since the No Child Left Behind (NCLB) mandate. No longer is money being thrown at the purchase of the latest technological carrot with no regard to assessment of the time teachers used the technology. In a study of technology used in the Blue Valley School District (BVSD), Overland Park, Kansas, researcher Moore stated that over $40 million had been invested in his district over the past decade to place technology in the classrooms. Recently, "the school district initiated a teacher appraisal system that identifies six technology-related standards in the areas of curriculum, instruction, classroom management, communication, and professional development" (Moore). Taxpayers were demanding justification of all money being spent on technology in the BVSD. Moore suggested that the greatest technology in the world would do little for students if it were not used. Moore stated "from the report[s] and profiles, individual teachers, schools, and the district were able to set improvement goals for technology integration." In short, using the accountability practices set by the Blue Valley School District, teachers had to monitor the amount of time they used technology. Thus, Moore and the BVSC supported the existence of a correlation between the amount of time teachers used technology to teach and student achievement.

Current educational research supports an overall relationship between the amount of time teachers use technology as a teaching tool and student achievement. For decades, educators have been exposing students to various types of technology. However, only recently have more and more classroom teachers begun actually to use technology to teach. As current data supports, when educators use technology to teach, student achievement increases (Moore). Other researchers, such as Ury, also find a correlation between the amount of time teachers use technology to teach and student achievement. How strong were the connections; what specific amount of time using the technology would be sufficient to raise student achievement; how do educator best assess student achievement in math? Additional studies, such as this one, are required to answer such questions.

Math MAP Test as a Valid Assessment Tool of Math Students

The state of Missouri experienced educational reforms following passage of the Outstanding Schools Act of 1993. A valid student, teacher, and school assessment tool was needed. The MAP's implementation changed education in Missouri. The emphasis was no longer focused solely on what students knew, but also on how students could exhibit their knowledge. The assessment practices used prior to 1993 were replaced by the performance-based assessment theory (Jones 25).

Since 1995, Missouri has used the Missouri Assessment Program (MAP) performance-based test to measure student knowledge in core areas. According to DESE, the MAP test is a valid assessment of student achievement. The MAP test is administered at the following levels:

1. Communication Arts, Grades 3, 7, and 11
2. Mathematics, Grades 4, 8, and 10
3. Science, Grades 3, 7, and 10
4. Social Studies, Grades 4, 8, and 11 ("Missouri Mastery")

The MAP "includes three types of test items: multiple choice, constructed response, and performance events. Multiple-choice: These items present students with a question followed by four or five response options, one of which is correct. The multiple-choice portion (Terra Nova) is a nationally normed, machine-scored test" Missouri Master"). Constructed response items require students to supply, rather than select, an appropriate response. Students might be asked to provide a one-word answer, to complete a sentence, or to show their work in solving a problem. Performance events require students to work through a complicated problem, to conduct an experiment, or to present a written argument. Students have from 15 to 45 minutes to complete a performance event. Constructed-response items and performance events are scored with predefined rubrics ("Missouri Mastery" 1).

Literature relating to the MAP test was explored in order to determine its validity as an assessment tool for student achievement. In his dissertation, James K. Jones studied the validity of the MAP test. The specific focus of Jones's study was to determine the strength of the relationship between the MAP scores and student achievement. Quantitative data was collected on 1000 students from 20 mid-sized Missouri school districts. Jones's study revealed a strong correlation between student achievement and MAP scores, thus supporting the MAP test as a valid tool for assessing student achievement. A 2006 study by Bob Willis focused on technology use, mathematics, and MAP scores. Willis sought to address the problem of the lack of empirical data supporting the MAP test as a valid measure of mathematical achievement for eighth-grade students. Willis compared the Math MAP scores of eighth graders who had completed a technology course to the scores of those who had not. First, Willis found that students who had completed the technology course had the highest mean scores on the MAP test; second, his data suggested that that the MAP test was a valid instrument for assessing student achievement in math. Thus, his data supported not only the validity of the MAP as a valid measurement of student achievement, but also using technology to teach mathematics. Therefore, according to a review of literature, the MAP was found to be a valid predictor of student development, not only in a general classroom, but also for math students specifically. Thus, for this study, the effects of interactive whiteboards and Interwrite Pads on student achievement could be measured by individual Math MAP scores.

Opposing Views

Although none would argue against the fact that there has been a significant increase in spending or a drastic boost in the use of technology in public schools over the last decade, one might contest the legitimacy of the role teaching technology actually plays in student achievement. Though most educators accepted the importance of technology in education, many question what the best practices for the implementation of individual technological teaching tools are. Rickman and Grudzinski suggested that the inappropriate use of technology in a learning environment could negatively affect learning, even if students were highly motivated (Kongrith 41). Though research supports the notion that the introduction of technology, such as the interactive whiteboard and Interwrite Pad, should have a positive effect on student learning, and though additional research established a correlation between the amount of time the technology was used and student achievement, many argued that both theories are predicated by teachers actually using the technology. That is, simply having the technology in a classroom, such as those in the SJSD math classrooms, will have little effect on student achievement unless the technology is used. Opposing views support Dewitt's claim that those who made blind declarations of "technology raising student scores spoke to the lack of evidence that putting computers in schools increases student achievement or results in individuals who were more prepared for the economic, political, or social challenges that await them in the real world of adulthood" (204). Some would argue that additional research is needed to justify unyielding support of using teaching technology.

Evidence shows that changes in educational systems and practices occurred as a "slow evolution" (Cuban "Oversold"). Cuban's "slow evolution" explanation suggested that "information technologies will eventually transform schooling, but that it will take a long time for teachers, students, and school organizations to fully adopt changes" (qtd. in DeWitt 51). Furthermore, the framework for assessing such achievement will also need to grow and change as the pedagogies transform. Results from performance exams are often used by state government officials to direct reforms made in the area of curriculum and instruction. Although classroom teaching procedures are quick to change, state mandated assessments and other assessments based on such evaluations tend to evolve at a much slower rate. Past and current researchers argue that although technology could be beneficial to education, teaching theories, educational frameworks, and even the amount of time teachers use the technology, need to evolve as technology itself does.

Conclusion of Literature Review

Some believe in the slow evolution of technology in teaching. Others propose that, "with the current trends of our technology-based society, methods of instructional delivery are rapidly changing to include software, computer models, the Internet, and web-based instruction" (Lindsay 1). In conclusion, common educational practices supported the notion that technology could have a strong positive influence on student achievement. Opposing views simply argued that, though the use of technology could help raise scores in education, teachers needed to be aware of changing pedagogies, best practices, and applications. This researcher concluded that the use of technology would have an impact on student achievement, but it was within the amount of time used that educators could find the best source for raising student achievement in math.

No matter how much time teachers have or have not spent using technology to teach in the past, "educators in all subject areas need to find and employ technological teaching methods to help students succeed" (Lindsay 1). The aforementioned literature and research studies support the possible effect of interactive whiteboards and Interwrite Pads on student achievement in math. Research also validates the importance of the amount of time math teachers use technology and its relationship to student achievement. With the review of literature gathered and data analyzed, this researcher concluded that the use of both the interactive whiteboard and Interwrite Pad would have a positive effect on, and the amount of time teachers used the technology would have a strong relationship to, student achievement in math. A review of literature also showed the dependent variable, Math MAP scores, to be a valid and useful tool in for assessing student achievement. The following study attempted to find the significance of the effect that the specific teaching technology had on student achievement and to find the strength of correlation between the amount of time a math teacher used specific technology and student achievement.

Chapter Three:

Research Methodology

School districts have spent enormous amounts of money to implement technology in high schools. The focus of this study was to determine if there was a significant difference in Missouri Assessment Program (MAP) scores prior to and after the introduction of the interactive whiteboards and Interwrite Pads into SJSD math classrooms. A second purpose of this study was to determine the strength of the relationship between the amount of time SJSD math teachers used both the interactive whiteboards and Interwrite Pads, as defined by the TUS/FTUS, and student achievement, as defined by Math MAP change scores. The technology explored in this study was available daily in all the SJSD secondary math classrooms prior to the 2005-2006 school year. Chapter Three explains the research methodology for this study and provides a description for research design, population and sample, instrumentation, data collection, and data anlaysis.

Research Design

Overall, a correlational-descriptive research design was used for this study. Descriptive research methodology was used to determine if there was a significant difference ($\alpha = .05$) between math scores on the Math MAP test before and after the introduction of interactive whiteboards and Interwrite Pads. Correlational research methodology was used to find the level of significant relationship ($\alpha = .05$) between the amount of time math teachers used the interactive whiteboard, as measured by the TUS, and student achievement, as measured by individual scores on the Math MAP. It was also used to find the level of significant relationship ($\alpha = .05$) between the amount of time math teachers used the Interwrite Pads and student achievement. The hypotheses tested in the study were:

- *Hypothesis #1:* There is a significant difference ($\alpha = .05$) between scores on the Math MAP test before and after the introduction of interactive whiteboards and Interwrite Pads.
- *Hypothesis #2:* There is a significant relationship ($\alpha = .05$) between the amount of time math teachers use the interactive whiteboard, as measured by the TUS, and student achievement, as measured by individual scores on the Math MAP.
- *Hypothesis #3:* There is a significant relationship ($\alpha = .05$) between the amount of time math teachers use the Interwrite Pads, as measured by the TUS, and student achievement, as measured by individual math scores on the MAP.

Population and Sample

Population: The population for this study was defined as all middle and high school students in the SJSD. Each year, approximately 900 students graduate from the SJSD (“Statistic Profile”). The students from the classes of 2007, 2008, and 2009 were enrolled at one of four middle schools and one of three high schools in the SJSD:

—Bode Middle School: Approximately 460 students annually

—Robidoux Middle School: Approximately 360 students annually

—Spring Garden Middle School: Approximately 450 students annually

—Truman Middle School: Approximately 430 students annually

—Benton High School: Approximately 800 students annually

—Central High School: Approximately 1300 students annually

—Lafayette High School: Approximately 800 students annually

Sample students were taken from the population of 2,722 students.

Sample: The sample was selected based on the students' presence when the specific technology was used during the time frame of the study (test group: class of 2008 and 2009) and on some students' presence during a time when the specific technology was not in use (control group: class of 2007). The interactive whiteboards and Interwrite Pads were introduced in all math courses starting with the 2005-2006 school year. From the population, 640 students were selected from the class of 2007, 617 from the class of 2008, and 427 from the class of 2009. Thus, the sample size for this study was 1684 students. The following selection criteria were used for inclusion and exclusion when choosing the sample study groups:

1. Sample members for the control and test group were enrolled in either the SJSD graduating class of 2007, 2008, or 2009 from their eighth grade until at least their tenth-grade year. (Hypothesis #1-#3)
2. Sample members had to have taken at least one math course each semester, from eighth grade through the tenth-grade. (Hypothesis #1-#3)
3. Sample members had to be classified as "regular students" and not "special needs students" as defined by the SJSD. (Hypothesis #1-#3)
4. Math teacher for students in the Class of 2008 and 2009 (those classes who had the specific technology used in the classroom) were given the opportunity to fill out the TUS and FTUS. (Hypothesis #2 and #3)

The students sample numbers broke down as follows:

Table 2

Sample Groups

Graduating Class	Population	Sample Groups
2007	923	640
2008	881	617
2009	918	427

Rationale for Selection Criteria: The graduating classes of 2008 and 2009 were chosen for the primary sample groups because both classes participated in Math MAP testing prior to and after the introduction of the technology. The class of 2007 was chosen as a control group because both Math MAP tests were taken prior to 2005-2006.

Instrumentation

Three instruments were used in this study: The Technology Usage Survey (TUS), The Follow-up Technology Usage Survey (FTUS), and the Math Missouri Assessment Program (MAP) Test.

Technology Usage Survey (TUS)

Description of Use: The purpose of the ten-question TUS was to gather teacher employment information and history, level of educational training, and the amount of time each teacher used the interactive whiteboard and/or the Interwrite Pad.

Measurement: The TUS was used to measure teachers': work history, gender, level of education, level of certification, and the amount of technology use. The questions of the TUS were written to gather that specific data. Question #1 of the TUS was used to acquire a teacher's SJSD Employee ID#. Questions #2 through #5 pertained to gathering information regarding a teacher's employment history. Question #6 asked about a teacher's gender. Questions #7 and #8 focused on a teacher's level of educational certification and personal education respectively. Finally, questions #9 and #10 were used to acquire the amount of time (in minutes) that a teacher used the interactive whiteboard and/or the Interwrite Pads in a given class period. The TUS was an appropriate instrument of measurement for the test population and setting because it could be used to collect pertinent demographical teacher information, as well as specific technology time usage information for both the interactive whiteboard (used to test Hypothesis #2) and Interwrite Pads (used to test Hypothesis #3).

Validity and Reliability: The validity and reliability of the TUS was maintained by making inferences based only on the data gathered specifically from the TUS questions.

Follow-up Technology Usage Survey (FTUS):

Description of Use: The purpose of the eight-question FTUS was to ascertain the number of professional development hours each teacher had for using each technology, data pertaining to teachers' perception about using teaching technology to raise student achievement, and teachers' methods for using the interactive whiteboard and Interwrite Pad (See Appendix F).

Measurement: The FTUS was comprised of questions that were used to measure information pertaining to teachers' feelings about the effectiveness of using technology, level of professional development, and methods for using the technology. The questions of the FTUS were written to gather that specific data. Question #1 of the FTUS was used to verify the teacher's SJSD Employee ID#. Questions #2 and #3 were used to acquire the amount of teacher professional development hours for use with the interactive whiteboard and/or Interwrite Pads. Questions #4 through #6 focused on a teacher's perception of general teaching technology, interactive whiteboards, and Interwrite Pads and their effects on raising student achievement. Finally, questions #7 and #8 provided teachers an opportunity to state how they specifically used, or did not use, the interactive whiteboard and/or Interwrite Pads. The FTUS was an appropriate instrument for measurement of the test population and setting because it could be used to collect pertinent teacher training information, teacher perceptions of technology effectiveness on student achievement data, and examples of specific teacher methods for using the technology of this study.

Validity and Reliability: The validity and reliability of the FTUS was maintained by making inferences based only on the data gathered specifically from the FTUS questions.

Missouri Assessment Program (MAP) Test

Description of Use: Math MAP Test scores were used to measure student achievement in this study. In response to the Outstanding Schools Act of 1993, Senate Bill 380 ("Assessment Standards"), the State Board of Education directed the Missouri Department of Elementary and Secondary Education (the Department) to identify the knowledge, skills, and competencies that Missouri students should acquire by the time they complete high school and to assess student progress toward those academic standards. The Department worked with teachers, school administrators, parents, and business professionals throughout the state, first to design the standards and later to develop means by which to assess them (Assessment Standard 4).

Measurement: Administration of the MAP test is a statewide annual assessment event. The scores are meant to be used by school districts for data analysis:

> In designated grade levels several methods are used to score the different components of the state assessment. Multiple-choice items are machine scored…constructed-response items and performance events are hand scored by professional item readers. Uniformity of scoring is ensured by rigorous training and the use of item-specific scoring guides. Scoring is organized and conducted by Missouri's contractor CTB/McGraw-Hill. ("Assessment" 6).

School districts use individual MAP scores to define student achievement in specific academic areas within the district, such as the Math MAP for mathematics. The scores are then used to determine the affectability of educational practice. The Math MAP scores were deemed a viable instrument for measuring student achievement in mathematics for the sample students in this study. Therefore, they were used to test Hypotheses #1, #2, and #3.

Validity and Reliability: In a 2006-2007 study of the MAP test, reviewers found the MAP to be an ideal assessment tool and an appropriate instrument for study. The reviewers found that assessment values of the MAP test were either fully aligned or reasonably aligned with the state's Show-Me Standards ("Alignment" 6). DESE cited multiple sources that supported the MAP as a valid and reliable testing instrument. As stated in a 1998 CTB/McGraw-Hill technical report, *Linking the Grade 8 Missouri Mathematics Assessment to the Trends in International Mathematics and Science Study (TIMSS)*, virtually all of the statistical data collected supported claims of the MAP to be a legitimate assessment instrument. To ensure reliability, Missouri teachers rescore a sample of the performance section of the MAP. The reliability coefficients between the rescores of the MAP test ran from .882 to .940. The CTB/McGraw-Hill's report also supported the MAP test as a valid and reliable assessment tool, finding, "evidence relevant to the technical quality of a testing system [MAP]…evidence of careful test construction, and adequate score reliability" ("Assessment Standards" 7). Thus, the MAP test was qualified as both valid and reliable.

Data Collection Procedures

TUS Teacher Response Collection: The TUS was administered online using the web-based survey tool, SurveyMonkey.com. The survey was open for response from December 1st through December 15th. All SJSD middle school and high school math teachers were asked to take the TUS. Using Microsoft Excel, the researcher recorded and aligned TUS responses to the individual six-digit employee number (a number assigned at random to each SJSD teacher) and then sorted by survey question response for each teacher. Next, Microsoft Excel was used to align teacher data was with student data (e.g. student Math MAP scores were aligned to the teacher responses about time of usage on the TUS).

FTUS Teacher Response Collection: The FTUS was administered online using the web-based survey tool, SurveyMonkey.com. The survey was open for response from February 9th through February 20th. All SJSD middle school and high school math teachers were asked to take the FTUS. Using Microsoft Excel, the researcher recorded and aligned individual teacher FTUS responses to their original TUS responses.

Student MAP Scores Collection: Math MAP scores for all control and test students within the Classes of 2007, 2008, and 2009 were collected from the SJSD Student Achievement and Student Information system (SASI). SASI is directly linked to the DESE statistical website, and all students' MAP scores are housed in the SASI data files. The eighth and tenth grade Math MAP scores were collected in December 2008 for the Classes of 2007, 2008 and 2009, respectively. Using Microsoft Excel, MAP scores were aligned to individual SJSD student ID number. Students who did not have MAP scores for both the eighth grade and tenth grade MAP tests were excluded from the study.

Data Analysis

Descriptive Statistics

TUS: There were seven descriptive statistics calculated and reported from the TUS, which included group means and standard deviation for the:

1. year started in the SJSD.
2. number of years teaching in public education.
3. number of years teaching at either the middle and/or high school.
4. number of years teaching Math at either the middle school and/or high school level.
5. gender.
6. level of educational certification.
7. level of personal education.

SPSS software was used to find the mean and standard deviation for each descriptive statistic.

FTUS: There were seven descriptive statistics calculated and reported from the FTUS, which included group means and standard deviation for:

1. professional development hours using interactive whiteboards.
2. professional development hours using Interwrite Pads.

3. teachers' perception (Likert Scale) of the importance of using technology to raise student achievement.
4. teachers' perception (Likert Scale) of the importance of using interactive whiteboards to raise student achievement.
5. teachers' perception (Likert Scale) of the importance of using Interwrite Pads to raise student achievement.

SPSS software was used to find the mean and standard deviations for each descriptive statistic.

Hypotheses Testing

The following research hypotheses were tested for this study. Hypotheses 1-3 were derived from Research Questions 1-3, respectively.

Hypothesis #1: There is a significant difference ($\alpha = .05$) between scores on the Math MAP test before and after the introduction of interactive whiteboards and Interwrite Pads.

A one-way repeated measure of analysis of variance (ANOVA) is described as a procedure which performs an analysis of variance to test whether or not the means more than two populations are equal., with "repeated measurements of the same variable (under different conditions or at different points in time) on the same subjects" ("ANOVA/MANOVA"). A difference variable was calculated to find the change in students' eighth to tenth grade MAP Scores for the class of 2007, 2008, and 2009. Next, by means of SPSS software a one-factor repeated measures ANOVA was used to determine if significant differences ($\alpha = .05$) in the dependent variable "Math MAP scores" existed among the independent variable "class"(2007, 2008, and 2009)." Hypothesis #1 was tested by this method.

Hypothesis #2: There is a significant relationship ($\alpha= .05$) between the amount of time math teachers use the interactive whiteboard, as measured by the TUS, and student achievement, as measured by individual scores on the Math MAP.

The Pearson product-moment correlation coefficient, "is a common measure of the correlation (linear dependence) between two variables X and Y" (Rodgers and Nicewander 59). Using SPSS software, the Pearson product-moment correlation coefficient (PMCC) was used to test the strength and direction of the linear relationship ($\alpha = .05$) between the independent variable "amount of time interactive whiteboards were used" (obtained from TUS Question #9) and the dependent variable "10th Grade Math MAP Test Scores." Three Pearson product-moment correlation coefficients were calculated to find the strength of relationship between the amount of time interactive whiteboards were used by 1) tenth grade (2008), 2) ninth grade (2009), and 3)tenth grade (2009) math teachers and tenth-grade Math MAP Test scores. Regression analysis "is a collective name for techniques for the modeling and analysis of numerical data consisting of values of a dependent variable and of one or more independent variables" (Berk 1). In this study, "amount of time interactive whiteboards were used" was applied as a predictor of Math MAP Test scores. Hypothesis #2 was tested by this method.

Hypothesis #3: There is a significant relationship ($\alpha = .05$) between the amount of time math teachers use the Interwrite Pads, as measured by the TUS, and student achievement, as measured by individual math scores on the MAP.

Using SPSS software, the Pearson product-moment correlation coefficient (PMCC) was used to test the strength and direction of the linear relationship ($\alpha = .05$) between the independent variable "amount of time Interwrite Pads were used" (obtained from TUS Question #10) and the dependent variable "10th Grade Math MAP Test Scores." Three Pearson product-moment correlation coefficients were calculated to find the strength of relationship between the amount of time Interwrite Pads were used by 1) tenth grade (2008), 2) ninth grade (2009), and 3)tenth grade (2009) math teachers and tenth grade Math MAP Test scores. The amount of time Interwrite Pads were used was also applied as a predictor of Math MAP Test scores. Hypothesis #3 was tested by this method.

Limitations

Several limitations, defined as an uncontrollable factor that may or will affect the study (Mauch and Birch 103), were identified for this study. The following limitations were identified to guide the interpretation of this study.

One limitation of the study is the potential for different teaching styles. Individual middle and high school math teachers in the SJSD may teach in different ways. This may create a potential for alternative explanations for any observed differences in achievement.

A further limitation of the study is the potential effect that the introduction of the 2005-2006 K-8 Math Curriculum had on student achievement. The introduction of new teaching practices and textbooks may cause a potential for alternative explanations of the results.

Summary

The researcher looked at a selected number of the high school math students in the SJSD over a period of five years. The sample group was comprised of 1684 students. The Classes of 2007, 2008, and 2009 were studied. All three subgroups were simultaneously studied with regard to Math MAP scores during the research time frame, prior to and after the initiation of district-wide use of interactive whiteboards and Interwrite Pads in all SJSD math classes. Teachers of the math classes studied were given demographic surveys, which were used to gather information about: the percentage of time that teachers used technology daily, gender, years of service, years of teaching math in their current building, percentage of interactive whiteboard and Interwrite Pad usage daily, and percentage of training provided for using the technology.

Chapter Four

Results

The purpose of this study was to determine the effect that the introduction of technology into math classrooms has on student achievement. Interactive whiteboards and Interwrite Pads were placed in all SJSD middle- and high-school math classrooms prior to the start of the 2005-2006 school year. The population of the study was identified as all students in the classes of 2007, 2008, and 2009 ($N = 2,722$). An overall sample ($n = 1,684$) was taken from each class (2007, $n = 640$; 2008, $n = 617$; 2009, $n = 427$). Middle school and high school math teachers were given technology usage surveys (TUS and FTUS). MAP change scores were used to test all hypotheses, while survey data was used to calculate descriptive statistics and to test Hypothesis #2 and Hypothesis #3. Chapter Four reports the results of: descriptive statistics, Hypothesis #1 Testing, Hypothesis #2 Testing, Hypothesis #3 Testing, and a summary of the results

Descriptive Statistics

SPSS software was used to find the mean and standard deviations for data collected from the TUS. The following data represent the average use (in minutes) of interactive whiteboards and Interwrite Pads; average years of teaching in general; and the average years of teaching mathematics in middle school and high school specifically. The descriptive statistics for those teachers who completed the TUS are shown in Table 3 below ($n = 34$).

Table 3

Technology Usage Survey Descriptive Statistics

	Mean	SD
Average Use (in minutes) Interactive Whiteboard	2.50	8.22
Average Use (in minutes) Interwrite Pads	43.79	10.90
Years Teaching MS and/or HS	11.39	9.44
Years Teaching MS and/or HS Math	10.82	8.30

The mean amount of time teachers used the interactive whiteboard in each 90 minute class was 2.5 minutes per class, whereas the average amount of time teachers used the Interwrite Pads was 43.79 minutes per 90 minute class. The mean number of years for teaching in public education was 13.07. The average number of years teaching was 10.06 years. On average, those teachers who took the TUS had been teaching at the middle- and/or high-school level for 11.39 years, with the standard deviation being 9.44 years. The mean number of years teachers had taught math at the middle- and/or high-school level was 10.82 years. The average number of years was 8.30 years.

SPSS software was used to find the mean and standard deviations for descriptive variable data collected from the FTUS. The following data represent the average time (in hours) of professional development for using the interactive whiteboards and Interwrite Pads, as well as the average feelings of teachers toward the use of technology in general, the interactive whiteboard, and Interwrite Pads, specifically. The statistics for those teachers who completed the FTUS are shown in Table 4 below (*n* = 32).

Table 4

Follow-up Technology Usage Survey Descriptive Statistics

	Mean	SD
PD with Interactive Whiteboards (in hours)	0.46	0.96
PD with Interwrite Pads (in hours)	1.86	1.97
Technology Effect on Student Math Achievement	4.03	0.73
Interactive Whiteboards Effect on Student Math Achievement	3.35	0.68
Interwrite Pads Effect on Student Math Achievement	3.62	0.68

On average, teachers who took the FTUS had .46 hours of professional development using the interactive whiteboards. The standard deviation from the mean was .96 hours. Teachers had an average of 1.86 hours of professional development using the Interwrite Pads. The standard deviation from the mean was 1.97 hours. Of those surveyed, teachers "agreed," "the use of teaching technology is an important factor for raising student achievement in math." They expressed a "neutral" feeling about "the use of the interactive whiteboard as a teaching tool is effective in raising student achievement in math." They articulated a "neutral" feeling about "the use of the Interwrite Pads as a teaching tool is effective in raising student achievement in math."

Hypothesis Testing

Hypothesis #1

The first research question asked in this study was: What is the effect of the introduction of interactive whiteboards and Interwrite Pads on student achievement? This question prompted Hypothesis #1: There is a significant difference ($\alpha = .05$)

between scores on the Math MAP test before and after the introduction of interactive whiteboards and Interwrite Pads.

A difference variable was calculated to find the change in students' eighth- to tenth-grade MAP Scores for the class of 2007 (no technology), 2008 (one year of technology), and 2009 (two years of technology). Next, a one-factor repeated measures ANOVA was used to determine if significant differences ($\alpha = .05$) in the dependent variable "Math MAP Scores" existed among the independent variable "class"(2007, 2008, and 2009). Table 5 below illustrates the sample size, mean score change, and standard deviation for each class.

The statistical data were as follows:

Table 5

Mean Change in Students' 8th and 10th Grade MAP change scores

Class	n	Mean	Standard Deviation
2007	639	29.94	45.23
2008	616	17.96	25.66
2009	426	19.43	24.85
Total	1681	22.89	34.71

Sample students from the class of 2007 (*n* = 639) had a mean score change of 29.94 and a standard deviation of 45.23. Class of 2008 sample students (*n* = 616) had a mean score change of 17.96 and a standard deviation growth 25.66. Sample students from the class of 2009 (*n* = 426) had a mean score change of 19.43 and a standard deviation of 34.71. The mean score change of all sample students (*n* = 1681) was 22.89 and the standard deviation was 34.71. After mean score changes were found, an ANOVA test was conducted to find the difference in means between classes (see Table 6, below).

Table 6

ANOVA Test Results

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Class	51824.14	2	25912.07	22.04	.000
Error	1972575.93	1678	1175.55		
Total	2904839.00	1681			

The F-statistic (F (*2, 1678*) = 22.04, $p < .05$), for the one-factor repeated measures ANOVA indicated a significant difference in test change scores occurred somewhere between the class of 2007 and 2009. To specify which means were different, a Tukey Honestly Significant Difference test was used to compare the class of 2007 with that of 2008, the class of 2008 with that of 2009, and the class of 2007 with that of 2009 (see Table 7, below). The Tukey HSD was chosen because it is generally considered more conservative than some post hoc tests (e.g. the Fisher LSD Test), but less conservative than other post hoc tests (e.g. Scheffe's Test) (Winer 140). The Tukey HSD results were as follows:

Table 7

Tukey Honestly Significant Difference Test Results 2007-2009

Class	Class	Mean Difference	Significance
2007	2008	11.97^*	.000
	2009	10.51^*	.000
2008	2007	-11.97^*	.000
	2009	-1.46	.776
2009	2007	-10.51^*	.000
	2008	1.47	.776

The results of the Tukey HSD showed the difference in the change in test scores from the class of 2007 to that of 2008 was 11.97 (*p* = .000). These results indicated a significant difference between the classes of 2007 and 2008's change scores. The results of the Tukey HSD also showed the difference in the change in test scores from 2008 to 2009 was -1.46 (*p* = .776). These results indicated no significant difference between the 2008 and 2009 change scores. The mean difference in the change score during the study timeline (2007 to 2009) was 10.51 (*p* = .000). These results indicated a significant difference between the 2007 and 2009 change scores. This difference is evidence that the class of 2007, which had no technology used, had the highest change score. Therefore, based on the tests results, the null hypothesis was rejected in favor of the hypothesis that there was a difference in MAP change scores before and after the introduction of interactive whiteboards and Interwrite Pads with scores prior to the introduction of the treatment being significantly higher than the scores after the introduction of the technology and with scores between 2008 and 2009 have no significant difference. However, the MAP change scores before the introduction of interactive whiteboards and Interwrite Pads (2007) were significantly higher than the MAP change scores after the introduction of the technology (2008 and 2009) and did not therefore provide a positive effect as anticipated.

Hypothesis #2

The second research question asked in this study was: What is the strength of the relationship between the amount of time math teachers use interactive whiteboards and student achievement? This question prompted Hypothesis #2: There is a significant relationship ($\alpha = .05$) between the amount of time math teachers use the interactive whiteboard, as measured by the TUS, and student achievement, as measured by individual scores on the Math MAP.

The Pearson product-moment correlation coefficient (PMCC) was used to test the strength and direction of the linear relationship ($\alpha = .05$) between the independent variable “amount of time interactive whiteboards were used” and the dependent variable “Tenth-grade Math MAP Test Scores.” Three Pearson product-moment correlation coefficients were calculated to find the strength of the relationship between the amount of time interactive whiteboards were used by 1) tenth-grade (class of 2008), 2) ninth grade (class of 2009), and 3) tenth-grade (class of 2009) math teachers and tenth-grade Math Test scores. Table 8 (page 60) summarizes the statistical data for students’ MAP change scores and teachers’ use of the interactive whiteboards ($n = 28$).

Table 8

Results: Correlation of Interactive Whiteboard Use and 10th Grade MAP change scores

Class of Teachers	Correlation Coefficient	Significance
Class of 2008 9th Grade Teachers	a	a
Class of 2008 10th Grade Teachers	-.332	.000
Class of 2009 9th Grade Teachers	b	b
Class of 2009 10th Grade Teachers	.109	.251

Note: a. Teacher data were not used because they taught prior to interactive whiteboards.

b. Cannot be computed because at least one of the variables is constant.

The correlation between the class of 2008 tenth-grade math teachers’ use of interactive whiteboards and tenth-grade MAP change scores ($r = -.332$) was significant ($p = .000$). The index was evidence of a moderate inverse relationship between x (teachers’ use of whiteboards) and y (tenth-grade MAP change scores). As the class of

2008 tenth-grade math teachers' use of interactive whiteboards increased (x), student Math MAP change scores (y) decreased. The first correlation provided significant evidence that supported the hypothesis that the introduction of technology would have an effect on test scores, however the effect was in a different direction as anticipated.

The correlation of the class of 2009 ninth-grade math teachers' use of interactive whiteboards and tenth-grade MAP change scores could not be calculated because all teachers recorded "0 minutes of use."

The correlation between the class of 2009 tenth-grade math teachers' use of interactive whiteboards and tenth-grade MAP change scores ($r = .109$) was not significant ($p = .251$). Thus, this test provided no significant evidence.

The two correlations provided mixed evidence. One test (2008-10th Grade Math Teachers) supported an inverse relationship and provided evidence that the null hypothesis should be rejected in favor of the hypothesis that there was a significant relationship between the use of interactive whiteboards and student achievement. However, the relationship was in a direction not anticipated. The second test (2009-10th Grade Math Teachers) evidenced no significant relationship.

Hypothesis #3

The final research question asked in this study was: What is the strength of the relationship between the amount of time math teachers use the Interwrite Pads and student achievement? This query prompted Hypothesis #3: There is a significant relationship ($\alpha = .05$) between the amount of time math teachers use the Interwrite Pads, as measured by the TUS, and student achievement, as measured by individual math scores on the MAP.

Using SPSS software, the Pearson product-moment correlation coefficient (PMCC) was used to test the strength and direction of the linear relationship ($\alpha = .05$) between the independent variable “amount of time Interwrite Pads were used” and the dependent variable “Tenth-grade Math MAP Test Scores.” Three Pearson product-moment correlation coefficients were calculated to find the strength of the relationship between the amount of time Interwrite Pads were used by 1) tenth-grade (class of 2008), 2) ninth grade (class of 2009), and 3) tenth-grade (class of 2009) math teachers and tenth-grade Math MAP Test scores. Table 9 summarizes the statistical data for students’ MAP change scores and teachers’ use of the Interwrite Pads ($n = 29$).

Table 9

Results: Correlation of Interwrite Pads Use and 10th Grade MAP change scores

Class of Teachers	Correlation Coefficient	Significance
Class of 2008 9th Grade Teachers	a	A
Class of 2008 10th Grade Teachers	0.379	.000
Class of 2009 9th Grade Teachers	0.175	0.142
Class of 2009 10th Grade Teachers	0.203	0.031

Note: a. Teacher data were not used because they taught prior to Interwrite Pads

The correlation between the class of 2008 tenth-grade math teachers’ use of Interwrite Pads and tenth-grade MAP change scores ($r = .379$) was significant ($p = .000$). The index was evidence of a moderate positive relationship between x (teachers’ use of Interwrite Pads) and y (tenth-grade MAP change scores). As the class of 2008 tenth-grade math teachers’ use of Interwrite Pads increased (x), student tenth-grade Math MAP change scores (y) increased. This correlation provided significant evidence that supported the hypothesis.

The correlation between the class of 2009 ninth-grade math teachers' use of Interwrite Pads and tenth-grade MAP change scores (*r* = .175) was not significant (*p* = .142). This test provided no significant evidence.

The correlation between the class of 2009 tenth-grade math teachers' use of Interwrite Pads and tenth-grade MAP change scores (*r* = .203) was significant (*p* = .031). The index evidenced a moderate positive relationship between x (teachers' use of Interwrite Pads) and y (tenth-grade MAP change scores). As the class of 2009 tenth-grade teachers' use of Interwrite Pads increased (x), student Math MAP change scores (y) increased. The final correlation provided significant evidence that supported the hypothesis.

The three correlations provided mixed evidence. Two tests (2008 and 2009-10th Grade Math Teachers) supported a positive relationship and provided evidence that the null hypothesis should be rejected in favor of the hypothesis that there was a significant relationship between the use of Interwrite Pads and student achievement. The second test (2009-9th Grade Math Teachers) evidenced no significant.

Summary

Statistical data related to the three research hypotheses for this study were presented in Chapter Four. The statistical results for this study were obtained by conducting a one-factor repeated measures ANOVA (Hypothesis #1) and six Pearson product-moment correlation coefficients (3-Hypothesis #2, 3-Hypothesis #3). The statistical results of this study were reported in tables and in narrative form. The questions guiding this study were: (1) What is the effect of the introduction of interactive whiteboards and Interwrite Pads on student achievement? (2) What is the strength of the relationship between the amount of time math teachers use interactive whiteboards and student achievement? (3) What is the strength of the relationship between the amount of time math teachers use the Interwrite Pads and student achievement? The findings for research Hypothesis #1 were that there was a significant difference in MAP change scores before and after the introduction of interactive whiteboards and Interwrite Pads with scores prior to the introduction of the treatment being significantly higher than the scores after the introduction of the technology. The findings for research Hypothesis #2 were mixed providing that there was a moderate inverse relationship between the amount of time teachers use interactive whiteboards and tenth-grade MAP change scores, as well as, no significant relationship. The findings for research Hypothesis #3 were mixed providing that there was a moderate positive relationship between the amount of time teachers use Interwrite Pads and tenth-grade MAP change scores, as well as, no significant relationship.

Chapter Five will present a summary of the findings, along with conclusions, interpretations, and recommendations, for the Saint Joseph School District.

Chapter Five

Interpretations and Recommendations

Prior to the start of the 2005-2006 school year, the Saint Joseph School District installed and implemented the use of interactive whiteboards and Interwrite Pads in all middle- and high-school math classrooms. The technology was integrated into current classroom practices with the intent of helping raise student achievement in math. As one math teacher reported, teachers used the interactive whiteboards and Interwrite Pads "to add notes to PowerPoints or website explanations; work example problems; give notes for discussion; and have students work example problems" ("FTUS" 1). This study tested the effect of the use of the specific technology on student learning in math. Study results could provide empirical data that could be used to guide the future purchase, maintenance, and staff training needed for the specific technology. That is, if the results of this study could show that the specific technology was effective in raising scores and/or if it evidenced that, a significant positive relationship existed between the use of the technology and student learning, then the SJSD could continue on its current path. However, if the study results showed an area or areas of no evidence of effectiveness then the data could be used to guide administrators toward creating policies and practices that would help teachers use the resources more effectively or not at all.

In Chapter Four, the findings of the study were presented. This chapter provides a study summary, findings related to the literature, conclusions associated with the findings, and recommendations for future research related to the use of the interactive whiteboard and Interwrite Pads.

Study Summary

Overview of the Problem

The Saint Joseph School District (SJSD) continuously explores new ways to strengthen the learning skills of all students and continues to allocate more and more funds to the purchase, implementation, and use of technology. This study considered the impact of the interactive whiteboard and Interwrite Pads on student learning in math.

Purpose Statement and Research Questions

The purpose of this correlational-descriptive research study was to determine if the introduction and use of interactive whiteboards and Interwrite Pads had an effect on student achievement in math and to determine if there was a significant relationship between the amount of time math teachers used the technology and student achievement. This study explored three research questions: (1) What is the effect of the introduction of interactive whiteboards and Interwrite Pads on student achievement? (2) What is the strength of the relationship between the amount of time math teachers use interactive whiteboards and student achievement? (3) What is the strength of the relationship between the amount of time math teachers use the Interwrite Pads and student achievement?

Review of the Methodology

From the SJSD classes of 2007, 2008, and 2009, students were selected for the study. Students' eighth-grade and tenth-grade MAP change scores were compared by class and the data were used to test Hypothesis #1. All SJSD middle- and high-school math teachers were asked to complete the TUS and FTUS. In addition to MAP change scores, the information gathered from the TUS was used to test Hypothesis #2 and

Hypothesis #3. Further data from the TUS, as well as information gathered by the FTUS were used to calculate descriptive statistics for this study.

Major Findings

The major findings for the three hypotheses were:

Hypothesis #1*:* There was a significant difference in MAP change scores before and after the introduction of interactive whiteboards and Interwrite Pads, with change scores prior to the introduction of the treatment (2007) being significantly higher than change scores after the introduction of the technology (2008); however, there was not a significant difference in change scores between the class of 2008 and 2009. These differences provided evidence that the class of 2007, which had no technology used, had the highest change score. Therefore, the test results would suggest that the longer the technology was used, the more adversely student achievement was affected. That is, the class of 2007 (no interactive whiteboard or Interwrite Pads), had significantly higher change scores than did either the class of 2008 (one year of technology) or the class of 2009 (two years of technology). The results of Hypothesis #1 testing, though supporting the hypothesis, did not signify a positive effect of technology as anticipated.

Hypothesis #2: There is a significant relationship between the amount of time math teachers use interactive whiteboards and MAP change scores. For the class of 2008's ninth-grade math teachers, the correlation index indicated a moderate inverse relationship between x (use of whiteboards) and y (tenth grade MAP change scores). A correlation index for the class of 2009's ninth grade teachers could not be calculated because all teachers recorded "0 minutes of use." For the class of 2009's tenth grade math teachers, the correlation index indicated a non-significant positive relationship between x and y. The two correlations provided mixed evidence. One test (2008-10th Grade Math Teachers) supported an inverse relationship and provided evidence that the null hypothesis should be rejected in favor of the hypothesis that there was a significant relationship between the use of interactive whiteboards and student achievement. However, the relationship was in a direction not anticipated. The second test (2009-10th Grade Math Teachers) supported no significant relationship.

Hypothesis #3: There is a significant relationship between the amount of time teachers use Interwrite Pads and MAP change scores. For the class of 2008's ninth-grade math teachers, the index indicated a moderate positive relationship between x (usage of Interwrite Pads) and y (tenth grade MAP change scores). For the class of 2009's ninth-grade math teachers, the correlation indexed indicated no relationship. For the class of 2009's tenth-grade math teachers, the correlation index indicated a moderate positive relationship between x and y. The three correlations provided mixed evidence.

Findings Related to the Literature

Research Question #1: Some related literature and research studies suggested that, if used, technology could have an effect on learner accomplishment in Math. As discussed in Chapter 2, Rita Lindsay studied six college algebra classes at a local community college. She found that there was some potential for raising student math scores through technology-based education (iv). In addition, specific statistical analysis of the effectiveness of the Interwrite Pad was explored in Lui et al.'s 2003 study. The study looked into the possibility of building a wireless classroom that worked in everyday, real-world classrooms, using such teaching technologies as interactive whiteboards and Interwrite Pads. The Lui study revealed that the use of wireless

Interwrite Pads and interactive whiteboards ultimately had a positive effect on student achievement (Lui et al. 371). Such studies support the theory that technology could have a positive effect on student achievement. According to the results of Hypothesis #1 testing, the longer technology was used in the classroom, the less change scores increased, thus contradicting some current research. However, additional research, such as that found in Gary Ury’s 2003 study, which explored administrators’ monitoring and assessment of teachers’ use of technology in relationship to the Technology Standards for School Administrators, found that technology “must be used continuously” to be an effective tool for raising student achievement (iv). That is, not using technology often enough to teach might have an adverse effect on student achievement. Therefore, as this study found that some of the technology was not being used often [interactive whiteboards were only used an average of 2.5 minutes per 90 minute class, see Table 3, above], the results of Hypothesis #1 testing would support findings by researchers such as Ury. Results might also support the “potential for effectiveness” discussed by authors, such as Lindsay and Lui, but several factors may have contributed to the mixed results.

Research Question #2: In reference to the relationship between the amount of time math teachers use interactive whiteboards and student achievement, related literature and research studies support a strong relationship between the amount of time teachers use such technology and learner accomplishment. In his 1995 study of Silicon Valley High School students, Larry Cuban found, in those classes that received at least some exposure to technology, students had the potential to do better academically (Cuban “How Teachers” 1). Cuban reported that teachers in the test group had accepted the educational theory that if teachers used technology often and were trained to use it effectively, more exposure to technology would ultimately lead to an increase in student achievement. With regard to the actual amount of time teachers used technology, he found, “Teacher use of technology during our random observations was the exception rather than the rule” (“How Teachers” 1). According to the results of one Hypothesis #2 test (2008-10th Grade Math Teachers), as the use of interactive whiteboards increased, the level of student achievement decreased. The results of Hypothesis #2 testing did, in part, support a need to use technology often. However, the teachers in this study did not do so with regard to the interactive whiteboard (see Table 3, above). In fact, one test group’s statistical data (2009-9th Grade Math Teachers) could not be computed because all respondents recorded “0 minutes of use.” Another Hypothesis #2 test (2009-10th Grade Math Teachers) showed a weak positive, but not significant, relationship. The contradiction of results may be linked to the lack of time used and/or lack of training for using interactive whiteboards. If teachers are not using the technology or do not know how to use the technology, then test results would not be consistent with congruent studies. Yet to further validate the outcomes of Hypothesis #2 testing, one might also note that there may have been additional outside influences, other than the lack of use (e.g. combination of using two teaching technologies at once and/or lack of teacher training), which may have had an effect on the study’s conclusions with regard to this hypothesis.

Research Question #3*:* Studies indicated that not only does the use of technological teaching tools, such as Interwrite Pads, raise student achievement but also the frequency/duration with which they are used could affect student learning (Hasting 1). In reference to the relationship between the amount of time math teachers use

Interwrite Pads and student achievement, related literature supports the idea of a strong positive relationship between the amount of time teachers use such technology and learner accomplishment. According to the results of two Hypothesis #3 tests (2008 and 2009-10th Grade Math Teachers), as the use of Interwrite Pads increased, the level of student achievement increased. Test results for 2009-9th Grade Math Teachers indicated no relationship. Though the results of the third test did not show significant support, they did not directly contradict current literature or the other two Hypothesis #3 tests that support Interwrite Pads as an effective teaching tool. Therefore, these overall results supported current knowledge that there is a significant relationship between the amount of time specific technology is used and learner accomplishment.

Conclusions

Implications for Action

The interpretations of this study's results could help guide administrators in making decisions, specifically about the repair or replacement of existing interactive whiteboards and Interwrite Pad. In addition, studies such as this one could be used to help guide the implementation of SJSD administrative policies and SJSD teachers' practices that would better utilize the amount of professional development and instructional use of specific technology.

As stated above, the results of this study indicated a difference in MAP change scores before and after the introduction of interactive whiteboards and Interwrite Pads, with scores prior to the introduction of the treatment being significantly higher than scores after the introduction of the technology. Several factors may have contributed to the significant, yet negative effect.

One factor may simply be that technology is ineffective, or even counterproductive, when used to teach math. That is, interactive whiteboards or Interwrite Pads by themselves, or when used together, may have an adverse effect on student achievement. This implication, however, would be in stark contrast to current literature and research. Thus, since Hypothesis #2 testing yielded results that suggested an inverse effect of interactive whiteboards and Hypothesis #3 test results indicated a strong positive relationship between Interwrite Pads and student achievement, one might conclude instead that interactive whiteboards alone may have contributed to the negative outcome of Hypothesis #1 testing. Therefore, it is recommended that Hypothesis #2 and #3 results be taken into account.

Another factor to consider with regard to the negative effect of technology on math students is teacher training. On average, teachers had less than thirty minutes training in use of the interactive whiteboards. From this, one might conclude that teachers were unsure of how to use the interactive whiteboards effectively. Therefore, they chose not to use it very often. Other technology, such as the Interwrite Pads, on which the teachers had more training and used more often, yielded a more positive effect on student achievement. Teachers may not have had sufficient professional development for using either the interactive whiteboards or Interwrite Pads. Thus, regardless of the potential effectiveness of the teaching technology, teachers may not have been properly trained to use the technology. One might conclude that training may have affected the effectiveness of using the specific technology in this study. Therefore, it is recommended that, if the SJSD is going to support the use of specific teaching technology, administrators must create policies that mandate more training in using the technology.

A second factor to consider is the amount of time the technology was used. Though some research supports the idea that the use of technology (including the interactive whiteboards and Interwrite Pads) has the potential to raise math students' test scores, the technology may not have been used often enough to have a positive effect. Thus, one might conclude that the outcome of higher test scores prior to the introduction of technology could be the results of lack of training for both the interactive whiteboard and Interwrite Pad, as well as the lack of use of interactive whiteboards because scores were actually higher after the introduction of the technology. It is recommended that administrators create and follow policies that encourage constant teacher use of the purchased technology that will help raise student achievement. It is further recommended that, based on the outcomes of this study, that the SJSD create and implement a SJSD Professional Development Technology Plan (PDTP). Through the collaboration of the SJSD Technology Committee (which is currently made up of representative from students, teachers, and administrators), this plan would include, but not be limited to, the creation of a:

1. SJSD Technology in Teaching Objectives List that would dictate master goals for using teaching technology in the classroom.
2. SJSD Preferred Teaching Technologies List that would outline the current, as well as, the potential teaching technologies being used or being considered for use in all SJSD classrooms.
3. SJSD Professional Development Technology Chart that would outline the types, amounts, durations, and calendar times for technology training that would be aligned with each form of technology used and/or considered for use in the SJSD.

4. SJSD Administrators' Technology Use and Assessment Plan which would outline methods for documenting that teachers are trained and effectively using the teaching technology in their classrooms.

Through the use of the PDTP, administrators, teachers, and students would be able to help ensure technology is being used properly, used often, and ultimately used to raise student achievement in every SJSD classroom.

As stated above, the mixed results of this study indicated an inverse relationship between the amount of interactive whiteboard use and student achievement, as well as no relationship. Several factors may have contributed to the significant, yet inverse effect.

One implication might be that interactive whiteboards may simply be an ineffective teaching tool for instructing math students. That is, the use of interactive whiteboards may have an adverse effect on student achievement because it was indeed an unproductive teaching technology. It is recommend, if further test prove this fact to be true, that the SJSD does not continue to support interactive whiteboard use.

A second factor to consider is teachers' perceptions of the effectiveness of the interactive whiteboard. Of those surveyed, teachers "agreed" that the use of teaching technology in general was effective in raising student achievement, but were "neutral" with regard to using interactive whiteboards. The results of the two questions contradict one another. It is recommended that the SJSD work to gather more teachers' perceptions from within the SJSD and from other similar school districts pertaining to the use of specific technology in the classroom and that the data be used to guide further policy and practices in the SJSD. That is, if those districts, like the SJSD, find an inverse relationship, then discontinuing the use of interactive whiteboards may be an option.

However, if SJSD administrators find similar districts are having positive effects with the technology, they may want to incorporate similar training and usage protocols. It is further recommended that regardless of the outcomes of studying other school districts, that the SJSD PDTP be used by all stakeholders in the SJSD.

Another factor that might have contributed to the contradiction in results may lie in the survey data collection. Teachers who taught during the study timeframe did not reply or did not provide sufficient teacher identification data to allow for the tabulation of their results. Forty out of sixty-one math teachers filled out the survey. Of those 40 teachers, 19 had taught math in the SJSD for the duration of the study timeline (since at least 2002-2003, the year of the Class of 2007's eighth grade MAP test). Some teachers left the district, moved on to different positions, or simply did not choose to fill out the survey. The number of complete survey response could have had an effect on Hypothesis #2 results. Therefore, it is recommended that the SJSD continue to conduct surveys, such as the TUS and FTUS, to gain additional insight to the use of technology in the SJSD. It is further recommended that the additional data generated by such surveys be used by the SJSD Technology Committed to help continuously access the SJSD PDTP.

A final factor to consider for the validation of study findings with regard to the relationship between the amount of time teachers used interactive whiteboards and student achievement is that of additional outside influences. Since many of the teachers in the study did not use interactive boards regularly (and some not at all), one might conclude that interactive whiteboard use, or more importantly the lack of use, might have had no effect on Hypothesis #2 testing outcomes whatsoever. That is, since interactive whiteboards were only used on average 2.5 minutes per 90-minute class, one might suggest this technology had no more bearing on the outcome of this test than taking attendance, writing passes to the bathroom, or any other daily classroom procedures. In addition, one might suggest that outside issues, entirely unrelated to the teaching technology (e.g. curriculum, classroom set up, etc.), may have affected the outcome of Hypothesis #2 testing. Therefore, it is recommended that further studies of the use of the interactive whiteboard be conducted in other subject areas (e.g. Social Studies, Language Arts, or Science) of the SJSD so that more reliable and valid information might be obtained to help make further conclusions and recommendations. It is further recommended that the additional data generated by such research be used by the SJSD Technology Committed to aid in continuously accessing the SJSD PDTP.

As stated above, the results of this study indicated a moderate positive relationship between the amount time Interwrite Pads were used and student achievement, as well as no relationship. One may conclude from the study results that the Interwrite Pads are effective teaching tools. Though some test results were not significant, they did show a weak positive relationship and did not contradict the other two positive tests. However, some additional factors may have contributed to the mixed results.

As with interactive whiteboards, one implication to consider is teachers' perceptions of the effectiveness of the Interwrite Pads. Of those surveyed, teachers were on average "neutral" with regard to the effectiveness (see Table 3, above) of Interwrite Pads in raising student achievement. However, teachers used the Interwrite Pads more often than the interactive whiteboards and had more training. The more that the Interwrite Pads are used; the more likely it is that student achievement will improve.

Therefore, it is recommended that administrators continue to create policies, such as those outlined in the SJSD PDTP, supporting the use of Interwrite Pads in the classroom and that teachers use the specific technology more often, while continuing to collect data pertaining to teachers' perception of effectiveness, level of training, and amount of use.

This study's results could help guide administrators in making decisions with regard to purchasing Interwrite Pads and, perhaps, other wireless teaching technology. Based on surveyed perception, math teachers are supportive of using technology in the classroom and are effective when using the Interwrite Pads. Results of studies like this one could help guide educators who use the Interwrite Pads toward ultimately raising student achievement in all academic areas.

The results of this study indicate that the introduction of specific technology, such as the interactive whiteboard and Interwrite Pads, can have a both a positive and negative effect on student achievement. This study also suggests that, in general, there is a significant relationship between how the amount of time teachers use technology and learner success. However, the research indicates that the amount of time spent using certain technology (interactive whiteboards) can actually have a inverse effect on student achievement, while the use of other technology (Interwrite Pads) can have a positive effect on learning. Thus, one might conclude, as supported by the results of Hypothesis #1 and Hypothesis #2 testing, the use of technology in general may adversely affect student achievement. However, one might further conclude, as supported by the results of Hypothesis #3 testing, that the use of some technology, such as the Interwrite Pads, may have the potential for raising student achievement.

Recommendations for Future Research

The following recommendations for future research related to the interactive whiteboard and Interwrite Pad are based on analysis and evaluation of results and findings from this study. These recommendation are but a few possible direction in which additional research could be taken.

One recommendation for future research is the exploration of different teaching technologies and their effects on student learning. Technology evolves so quickly that by the time studies are concluded, new pedagogies have been introduced to match the technology tested. Therefore, it continues to be necessary to study all manner of teaching technologies in order to gain a broader perspective of how technology affects teaching and learning in general.

A second recommendation for future study is the exploration of the effects of the interactive whiteboards and Interwrite Pads on different populations. One might hypothesize that teaching technology, such as interactive whiteboards and Interwrite Pads, may have varying effects on test groups that are younger or older, exposed more or less often to technology in general, and/or exposed more or less often to technology as teaching aids. Such variation in sample groups may add data to the ongoing study of technology.

A third recommendation for future study is to explore the effects of professional development in technology on teaching and learning. As technology changes so quickly, strategies for using those technologies can hardly keep up.

A fourth recommendation for future study is to run individual studies for each technology (interactive whiteboards and Interwrite Pads). One teaching technology may have great effects on another teaching technology.

A final recommendation would be to run studies, such as Ury's, to ensure that teachers are using technology based on national standards. Only after hard data is obtained can administrators truly know if the correct technology is being used and used often.

In summary, it is recommended that educators work to establish policies and practices that advocate appropriate professional development for the use of any and all teaching technologies. It is further recommended that additional studies be considered with regard to the effectiveness of both the interactive whiteboards and Interwrite Pads, as well as to the correlation between the use of specific technology and student achievement.

Concluding Remarks

It is recommended that educators, especially within the SJSD, use the findings and recommendations of this study to help guide future technology spending within their district. It is also recommended the teachers use statistical data from this study to outline the amount of, and need for, teaching technology in every classroom. Finally, it is advocated that the findings of this study be used to further develop the knowledge of all those within a professional learning community, especially the student. For what good is any educational study if it does not have the welfare of students as its foundation? As this study found, technology has the potential to raise student achievement; however, certain technology can adversely affect student learning. Appropriate technological teaching tools, such as the Interwrite Pads, need to be found and used constantly. As one teacher stated, “I use the Interwrite Pad every day. It is a great way for me to move to the back of the classroom, and let the learning be the focus instead of me. I also let my students do problems from their desk. They love writing on the Pad” (“FTUS” 1). However, teachers must use their tools often and well in order to shape the future of their students.

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APPENDIXES

Appendix A: Baker University Institutional Review Board Research Proposal

Appendix B: Baker University Institution Review Board Acceptance Letter

Appendix C: Saint Joseph School District Study Acceptance Letter

Appendix D: Saint Joseph School District Study Approval Form

Appendix E: Technology Usage Survey

Appendix F: Follow-up Technology Usage Survey

Appendix A: Baker University Institutional Review Board Research Proposal

BAKER
UNIVERSITY **June 1st, 2007**
SCHOOL OF EDUCATION
GRADUATE DEPARTMENT

Proposal for Research
Submitted to the Baker University Institutional Review Board

I. Research Investigators:

Department: School of Education: Doctor of Education in Educational Leadership

Name **Signature** **(Note: X=Faculty Sponsor)**

1. Dr. Willie Amison, Chief Advisor __________________________________ X
2. Dr. Brad Tate, Assisting Advisor __________________________________ X
3. Dr. Joe Watson, Assisting Advisor __________________________________
4. Dr. Tyran Sumy, Personal Advisor __________________________________

Principal investigator or faculty sponsor contact information:

1.	Willie Amison, Ed.D. Assistant Professor of Education Baker University 8001 College Blvd Overland Park, KS 66210	Phone: 913.491.4432 Email: wamison@bakeru.edu
2.	Brad Tate, Ed.D. Assistant Professor of Education Baker University 8001 College Blvd Overland Park, KS 66210	Phone: 913.491.4432 Email: btate@bakeru.edu
3.	Joe Watson, Ph.D. Assistant Professor of Education Baker University 8001 College Blvd Overland Park, KS 66210	Phone: 913.491.4432 Email: jwatson@bakeru.edu
4.	Dr. Tyran Sumy, Ph.D. Principal	Phone: 913.491.4432 Email: tyran.sumy@sjsd.k12.mo.us

Lafayette High School, SJSD
412 Highland Ave
Saint Joseph, MO 64505

Expected Category of Review: __Exempt _X_Expedited __Full

II. Protocol Title:

"Math Teachers' Usage of Interactive Whiteboards and Interwrite Pads and the Effect on Student Achievement"

Summary:

The following summary must accompany the proposal. Be specific about exactly what participants will experience, and about the protections that have been included to safeguard participants from harm. Careful attention to the following may help facilitate the review process:

In a sentence or two, please describe the background and purpose of the research.

The purpose of this study is to see if a relationship exists between Math Teachers' Usage, as defined by a teacher demographical survey, of interactive whiteboards and Interwrite Pads and student achievement in high school math classes, in specific, on Math MAP Scores and on Student Math GPAs. This study promises to provide a source for educators on all levels to be able to knowledgeably discuss the validity of use of technology in the classroom, with specific regard to Interactive Whiteboards and Interwrite Pads.

Briefly describe each condition or manipulation to be included within the study.

The condition/design of this study was a causal-comparative research case study design. Two primary test groups were chosen from Saint Joseph School District's middle and high school math students in the Class of 2008 and Class of 2009. Both primary test groups were divided into two subordinate test groups—Honors Math Track and NonHonors Math Track—as defined by the SJSD. All four subordinate test groups were used to test the hypotheses. During the time frame of the study (see Figure #1.6), the four test groups were exposed to the treatment of Interactive Whiteboards and InterWrite^{tm} Pads in all SJSD math classes. Math MAP Scores (8th grade & 10th grade) and Student Math GPAs were gathered for all students within the test groups, prior to and after the introduction of the treatment, and then used as measurement of student achievement.

What measures or observations will be taken in the study? If any questionnaire or other instruments are used, provide a brief description and attach a copy.

Student Achievement Setup: During the time frame of the study, the four test groups were exposed to the treatment of interactive whiteboards and Interwrite

Pads in all SJSD math classes. Math MAP Scores (8th grade & 10th grade) and Student Math GPAs were gathered for all students within the test groups, prior to and after the introduction of the treatment, and then used as measurement of student achievement.

Math Teacher's Usage of Treatment Setup: In addition to Math MAP and Math GPAs, all SJSD middle and high school math teachers were surveyed (see appendix A) with the Technology Usage Survey (TUS). This survey was used to ascertain data in areas of teacher demographical history, as well as, the amount of time math teachers in the SJSD used both technology in general and the treatment technology in specific.

—See attached copy, p. 6 "Technology Usage Survey"—

Will the subjects encounter risk of the psychological, social, or legal risk? If so, please describe the nature of the risk and any measures designed to mitigate that risk.

No risks are perceived to be encountered by any participant in the study. Furthermore, all names of students and teachers are recorded by student and teacher number and the research, nor the committee, will ever know anyone's actual name.

Will any stress to subjects be involved? If so, please describe.

No stress is perceived to be encountered by any participant in the study.

Will the subjects be deceived or misled in any way? If so, include an outline or script of debriefing.

It is not the intent to deceive or mislead the participants of this study in any way, therefore no debriefing is planned or seen necessary.

Will there be a request for information which subjects might consider to be personal or sensitive? If so, please include a description.

No request for information of a personal or sensitive nature is planned in this study.

Will the subject be presented with material which might be considered to be offensive, threatening, or degrading? If so, please include a description.

No material will be presented which might be considered offensive, threatening, or degrading.

Approximately how much time will be demanded of the subjects?

Students: No specific or "extra" amount of time will be asked of the students in the study as their Math MAP Scores and Math GPAs will be a result from testing times and in class times already mandated by the State of Missouri Department of Education.

Teachers: The math teachers in the study will be asked to fill out the 13 item Technology Usage Survey which should take approximately 5 minutes.

Who will be the subjects of the study? How will they be solicited or contacted? Provide an outline or script of the information which will be provided to the subjects prior to their volunteering to participate. Include a copy of any written solicitation as well as an outline of any oral solicitation.

All SJSD math students in the Class of 2008 and the Class of 2009 (as stated above), as well as, all math teachers in the SJSD that teach math classes to any of the subject students (as stated above) are to be studied. Students will not be solicited or contacted. The math teachers will be emailed a request to either print the attached Technology Usage Survey, complete, and return, OR will be able to access on online version of the survey.

What steps will be taken to insure that each subject's participation is voluntary? What if any inducements will be offered to the subjects for the participation?

All SJSD math students in the Class of 2008 and the Class of 2009 (as stated above), as well as, all math teachers in the SJSD that teach math classes to any of the subject students (as stated above) have been approved by the SJSD administration to be studied. —**See attached documents, p. 7, "SJSD: M. Shane Heard, Dissertation for Educational Doctorate (Ed.D.) Program, Baker University".**
There are no inducements planned.

How will you insure that the subjects give their consent prior to participating? Will a written consent form be used? If so, include the form. If not, explain why not.

All SJSD math students in the Class of 2008 and the Class of 2009 (as stated above), as well as, all math teachers in the SJSD that teach math classes to any of the subject students (as stated above) have been approved by the SJSD administration to be studied. —**See attached documents, p. 7, "SJSD: M. Shane Heard, Dissertation for Educational Doctorate (Ed.D.) Program, Baker University".** There are no inducements planned.

Will any aspect of the data be made a part of any permanent record that can be identified with the subject? If so, please explain the necessity.

No aspect of the data will be made a part of a permanent record that will individually identify any subject participation in this study.

Will the fact that a subject did or did not participate in a specific experiment or study be made part of any permanent record available to a supervisor, teacher, or employer? If so, explain.

> No information pertaining to a subject's participation, or lack thereof, will be made a part of any permanent record that will be available to a supervisor, teacher, or employer.

What steps will be taken to insure the confidentiality of the data?

> No names of either the students or teachers will ever be identified to the researcher, any other individual, or identifying aspect that reveal the privacy of said subjects.

If there are any risks involved in the study, are there any offsetting benefits that might accrue to either the subjects or society?

> No risks have been identified within the study pertaining to any offsetting benefits that might accrue to either the subjects or society.

Will any data from files or archival data be used? If so, please describe.

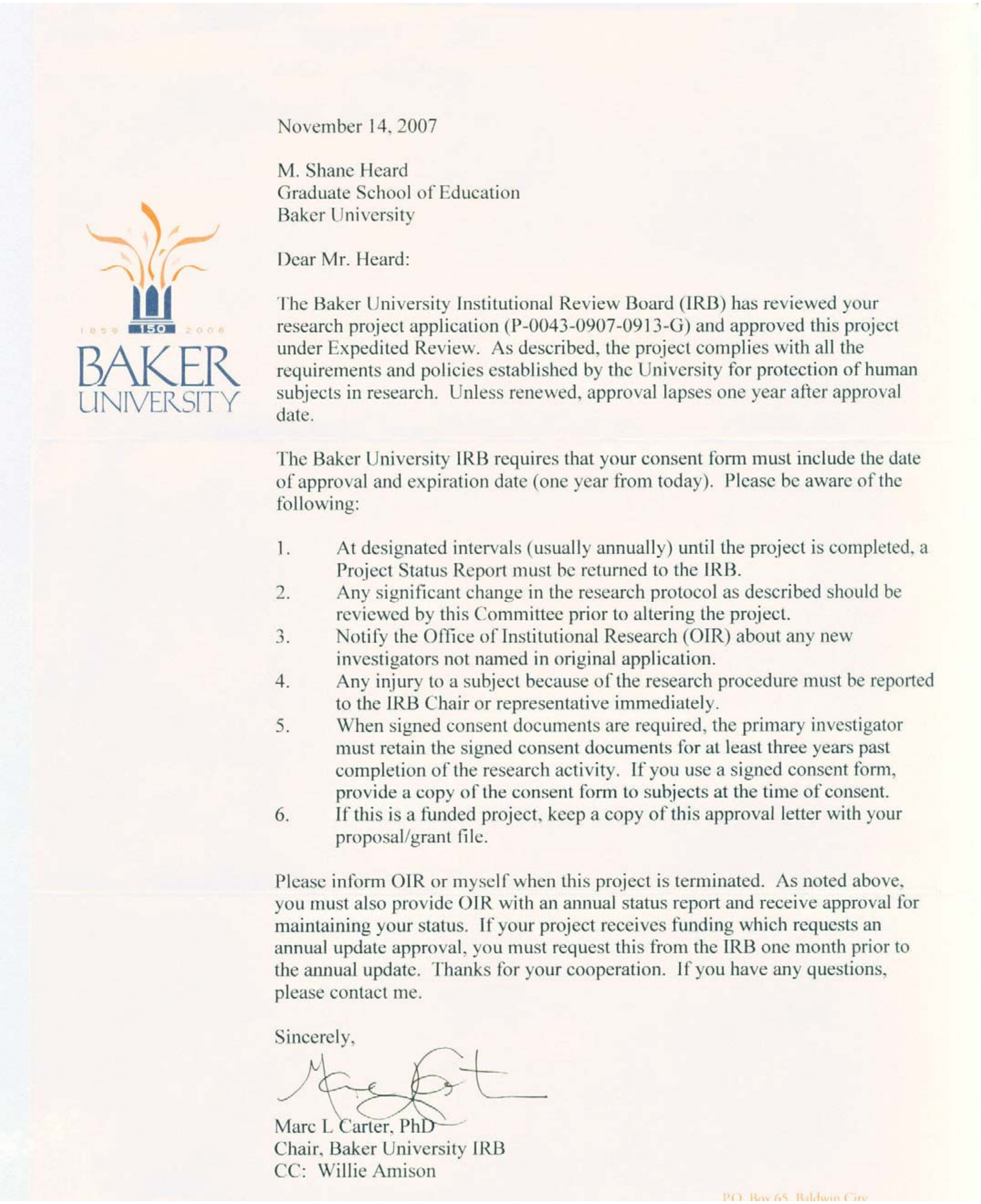
> It is anticipated that certain data may be obtained from the administrative office(s) with the SJSD SASI system, including records relating to Math MAP Scores, Math GPAs, Math Course Taken, Honor or NonHonors Track, and demographics.

Respectively submitted for your review this 1st day of June, 2007 by:

M. Shane Heard
Doctoral Student
Baker University
School Of Education
Graduate Department

Appendix B: Baker University Institutional Review Board Acceptance Letter

Appendix B: Baker University Institutional Review Board Acceptance Letter



1858 150 2008
BAKER
UNIVERSITY

November 14, 2007

M. Shane Heard
Graduate School of Education
Baker University

Dear Mr. Heard:

The Baker University Institutional Review Board (IRB) has reviewed your research project application (P-0043-0907-0913-G) and approved this project under Expedited Review. As described, the project complies with all the requirements and policies established by the University for protection of human subjects in research. Unless renewed, approval lapses one year after approval date.

The Baker University IRB requires that your consent form must include the date of approval and expiration date (one year from today). Please be aware of the following:

1. At designated intervals (usually annually) until the project is completed, a Project Status Report must be returned to the IRB.
2. Any significant change in the research protocol as described should be reviewed by this Committee prior to altering the project.
3. Notify the Office of Institutional Research (OIR) about any new investigators not named in original application.
4. Any injury to a subject because of the research procedure must be reported to the IRB Chair or representative immediately.
5. When signed consent documents are required, the primary investigator must retain the signed consent documents for at least three years past completion of the research activity. If you use a signed consent form, provide a copy of the consent form to subjects at the time of consent.
6. If this is a funded project, keep a copy of this approval letter with your proposal/grant file.

Please inform OIR or myself when this project is terminated. As noted above, you must also provide OIR with an annual status report and receive approval for maintaining your status. If your project receives funding which requests an annual update approval, you must request this from the IRB one month prior to the annual update. Thanks for your cooperation. If you have any questions, please contact me.

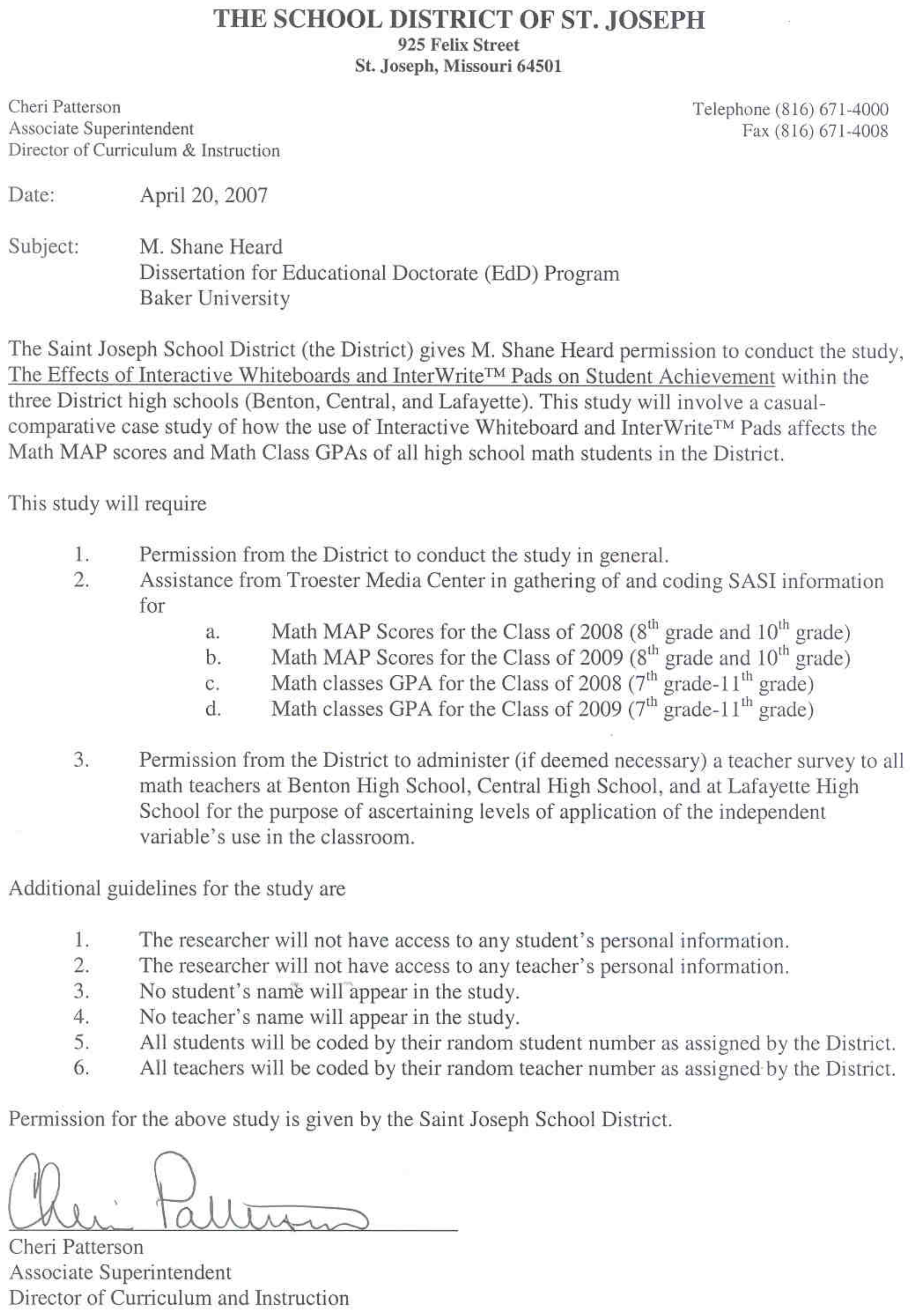
Sincerely,

Marc L Carter, PhD
Chair, Baker University IRB
CC: Willie Amison

P.O. Box 65, Baldwin City

Appendix C: Saint Joseph School District Study Acceptance Letter

Appendix C: Saint Joseph School District Study Acceptance Letter



THE SCHOOL DISTRICT OF ST. JOSEPH
925 Felix Street
St. Joseph, Missouri 64501

Cheri Patterson
Associate Superintendent
Director of Curriculum & Instruction

Telephone (816) 671-4000
Fax (816) 671-4008

Date: April 20, 2007

Subject: M. Shane Heard
Dissertation for Educational Doctorate (EdD) Program
Baker University

The Saint Joseph School District (the District) gives M. Shane Heard permission to conduct the study, The Effects of Interactive Whiteboards and InterWrite™ Pads on Student Achievement within the three District high schools (Benton, Central, and Lafayette). This study will involve a casual-comparative case study of how the use of Interactive Whiteboard and InterWrite™ Pads affects the Math MAP scores and Math Class GPAs of all high school math students in the District.

This study will require

1. Permission from the District to conduct the study in general.
2. Assistance from Troester Media Center in gathering of and coding SASI information for
    a. Math MAP Scores for the Class of 2008 (8th grade and 10th grade)
    b. Math MAP Scores for the Class of 2009 (8th grade and 10th grade)
    c. Math classes GPA for the Class of 2008 (7th grade-11th grade)
    d. Math classes GPA for the Class of 2009 (7th grade-11th grade)
3. Permission from the District to administer (if deemed necessary) a teacher survey to all math teachers at Benton High School, Central High School, and at Lafayette High School for the purpose of ascertaining levels of application of the independent variable's use in the classroom.

Additional guidelines for the study are

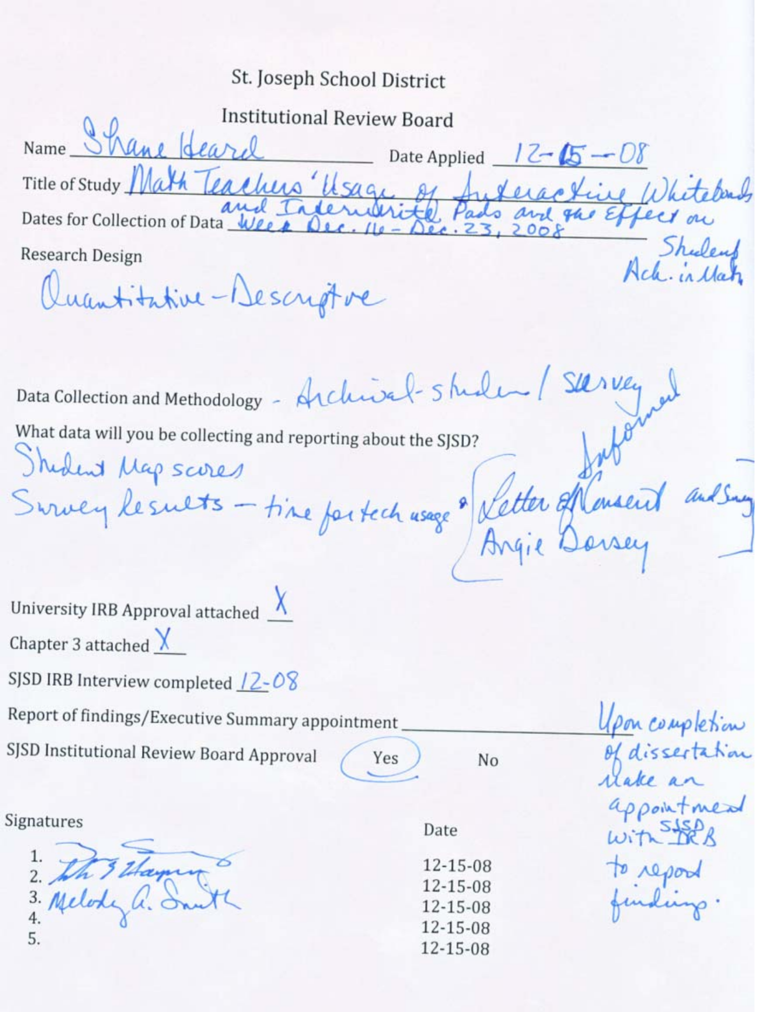
1. The researcher will not have access to any student's personal information.
2. The researcher will not have access to any teacher's personal information.
3. No student's name will appear in the study.
4. No teacher's name will appear in the study.
5. All students will be coded by their random student number as assigned by the District.
6. All teachers will be coded by their random teacher number as assigned by the District.

Permission for the above study is given by the Saint Joseph School District.

Cheri Patterson

Cheri Patterson
Associate Superintendent
Director of Curriculum and Instruction

Appendix D: Saint Joseph School District Study Approval Forms



St. Joseph School District

Institutional Review Board

Name Shane Heard Date Applied 12-15-08

Title of Study Math Teachers' Usage of Interactive Whiteboards and Interwrite Pads and the Effect on Student Ach. in Math

Dates for Collection of Data Week Dec. 16 - Dec. 23, 2008

Research Design

Quantitative - Descriptive

Data Collection and Methodology - Archival - student / survey

What data will you be collecting and reporting about the SJSD?

Student Map scores

Survey Results - time for tech usage

Informed Letter of Consent and Sur

Angie Dorsey

University IRB Approval attached X

Chapter 3 attached X

SJSD IRB Interview completed 12-08

Report of findings/Executive Summary appointment Upon completion of dissertation make an appointment with SJSD IRB to report findings.

SJSD Institutional Review Board Approval [✓ Yes] No

Signatures	Date
1.	12-15-08
2.	12-15-08
3. Melody A. Smith	12-15-08
4.	12-15-08
5.	12-15-08

"I have contacted Dr. Smith and Dr. Haynes of the SJSD IRB Committee and we have approved the follow-up survey. Please keep us posted on the results of your study.

>>> Dr. Tyran Sumy, 5 February 2009: 2:22pm >>>"

Source: Sumy, Tyran (tyran.sumy@sjsd.k12.mo.us). "SJSD IRB Committed Approval of FTUS." E-mail to M. Shane Heard (shane.heard@sjsd.k12.mo.us). 5 Feb. 2009.

Appendix E: Technology Usage Survey

Technology Usage Survey

Invitation Email to Saint Joseph School District Math Teachers

Dear Colleague:

I am a doctoral candidate in the Department of Education in Educational Leadership at Baker University. I am conducting research into the use of the interactive whiteboards and Interwrite Pads and the effect on student MAP scores in math. Your response to this 10-question electronic survey will take approximately five minutes to complete and will help me complete my research.

If you choose to participate in the study, please complete the on-line survey by connecting to the link before January 23rd. Though your individual six-digit employee is required for the purpose of comparing time of use of both the interactive whiteboard and Interwrite Pads, results will be key-coded before reporting and there will be no report of any specific identifiers. That is, neither I nor the St. Joseph School District will be able to track survey information by teacher's real name. Also, you may withdraw from this study or skip survey items without penalty. All information is confidential and anonymous.

If you have questions about this survey, please contact me at 816.671.4220 (w) or 816.233.5335 (h). You may also contact my advisor, Dr. Willie Amison, at Baker University.

Thank you in advance for your participation. I appreciate your giving thought and time to assist me in my research. I look forward to your participation in this research.

Respectfully,

M. Shane Heard

Link to survey:

http://www.surveymonkey.com/s.aspx?sm=gGuzn3QqkQRBIf2T5JDO4A_3d_3d

Technology Usage Survey

(Note: Your Six-digit Employee ID # (e.g. the number you use on “Requests for Leave”) will be the only means of identification used by the researcher. Personal information will never be obtained as you 6-Digit Employee ID# will be key-coded before results are reported.)

1. What is your SJSD 6-Digit Employee ID# (please see your administrator if you do not know your number). __________

2. What year did you start teaching in the St. Joseph School District? __________

3. How many years have you been teaching in public education? __________

4. How many years have you been teaching at either the middle school and/or high school level? __________

5. How many years have you been teaching Math at either the middle school and/or high school level? __________

6. What is your gender? ☐ Female ☐ Male

7. What is your current level of educational certification?
☐ Temporary Certification ☐ IPC ☐CCPC
☐ National Board

8. What is your current level of education?
☐ B.S.Ed. BA Masters Doctorate

9. In a given class period, I typically use the interactive whiteboards to aid in teaching ___________ minutes.

10. In a given class period, I typically use the Interwrite Pads to aid in teaching ___________ minutes.

Appendix F: Follow-up Technology Usage Survey

Follow-up Technology Usage Survey

Dear Colleague:

Please fill out the Follow-up Technology Usage Survey (FTUS). This small assessment tool will help me gather information that is very important to my study. The FTUS will help me gather additional data and would greatly increase the study's validity. Your help would certainly be appreciated. Please follow the link below and complete the survey by February 13th, 2009.

Link to survey:

http://www.surveymonkey.com/s.aspx?sm=Ufmejy_2fY6feyJQ_2btH9BJgQ_3d_3d

All information is confidential and anonymous. Neither I, nor the St. Joseph School District, will be able to track survey information by teacher's real name. You may withdraw from this study or skip survey items without penalty. In order to keep information confidential, all teacher identification data will be coded before results are reported.

If you have questions about this survey, please contact me at 816.671.4220 (w) or 816.233.5335 (h). You may also contact my advisor, Dr. Willie Amison, at Baker University.

Thank you in advance for your participation.

Respectfully,

M. Shane Heard

Follow-up Technology Usage Survey

Note: Your SJSD 6-Digit Employee ID# will be the only means of identification used by the researcher. Personal information will never be obtained by the researcher.

1. What is your SJSD 6-Digit Employee ID# __________?

Please answer questions two and three by placing the number of professional development hours in each blank.

2. I have had ___________ hours of professional development pertaining to the use of the interactive whiteboard as a teaching tool.

3. I have had ___________ hours of professional development pertaining to the use of the Interwrite Pad as a teaching tool.

Please answer questions four, five, and six by choosing the number corresponding to your choice. (1= Strongly Disagree, 2= Disagree, 3=Neutral, 4=Agree 5=Strongly Agree)

4. The use of teaching technology is an important factor for raising student achievement in math.

1	**2**	**3**	**4**	**5**
Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**

5. The use of the interactive whiteboard as a teaching tool is effective in raising student achievement in math.

1	**2**	**3**	**4**	**5**
Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**

6. The use of the Interwrite Pads as a teaching tool is effective in raising student achievement in math.

1	**2**	**3**	**4**	**5**
Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**

Please answer questions seven and eight in your own words.

7. With regard to teaching practices, how do you use the interactive whiteboard?

8. With regard to teaching practices, how do you use the Interwrite Pad?