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The Impact of the Interactive Electronic Whiteboard on Student Achievement in Middle School Mathematics

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THE IMPACT OF THE INTERACTIVE ELECTRONIC WHITEBOARD ON
STUDENT ACHIEVEMENT IN MIDDLE SCHOOL MATHEMATICS

by

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This action-research study was designed to determine the impact of the interactive electronic whiteboard in middle school mathematics. The researcher taught two seventh grade mathematics classes during a unit on transformations. The control class had access to the use of the interactive electronic whiteboard while the experimental class was taught without the use of the board. The sole independent variable was the use of the interactive electronic whiteboard (and lack of its use) in each class. Pre and post tests were given to measure the students’ change in visualization skills and content knowledge over the course of the instruction. Interviews with students were conducted to investigate the nature of the interactive whiteboard and its impact on student attitudes towards technology and student attitudes towards the teaching and learning of mathematics. The research showed no statistically significant difference in content learning or visualization gains, while student motivation and interest in their mathematics class increased.
CHAPTER 1

INTRODUCTION

Current educational trends show an increased use of technology in the classroom (Tate, 2002). Computers have been prevalent in schools for years, and as more peripherals are developed, more educators trained, and more students taught using new technological devices, the scope of traditional teaching is apt to change (Bell, 2000). From the introduction of the overhead projector in the classroom, to teacher’s use of television sets and video cassette recorders, graphing calculators, and emerging computer technology, the student’s interest and engagement inside of the classroom is apt to change as well.

Typical instruction in middle and high school mathematics classrooms have occurred with the use of certain tools that are almost standard to every classroom: a blackboard (chalkboard) or whiteboard (dry erase marker board). The introduction of the overhead projector, touted as the “classroom teacher’s best friend” (E. Jakubowski, personal interview, Spring 2003), changed the face to face delivery and instruction of concepts to students in all subjects. With today’s increased use of computers, lcd (liquid crystal display) projectors, and overhead screens (a typically flat, white surface that the image of an overhead projector is shinned upon), a new computer peripheral described as a “smart tool” (Bell, 2000), has emerged as a “kid magnet” that attracts both teachers and students (Bell, 2002): the interactive electronic whiteboard.

The interactive electronic whiteboard completely integrates the computer, lcd projector, and classroom whiteboard into an interactive, two-way, collaborative medium for teacher and student classroom practices.

Statement of Problem

With the developing introduction of the interactive electronic whiteboard into today’s classroom, current research is limited as such a new device, and its effects on teaching and student learning, are currently being explored (Cheetham, 2003, Micromath,
2003; REvIEW, 2002; Smart 2003). I was first introduced to the interactive electronic whiteboard during my student teaching requirement for graduation from Florida State University’s Mathematics Education undergraduate program. While interning at Florida State University School in Tallahassee, Florida, the inclusion of the interactive electronic whiteboard into my high school Algebra 2 classes became apparent and important. After the school received a grant to purchase several boards, one was awarded to my supervising teacher, and my curious mind sought everyday uses and means of incorporating the board into my daily class routine. While observing the students’ interest in the use of the board, questions from other teachers and in my own mind arose as to the educational impacts of the board on students and their learning.

Upon graduating and obtaining a Middle School Mathematics teaching position at the same school, and careful petition for placement of an interactive electronic whiteboard in my own classroom, I was faced with numerous questions (brought on by me) as to the usefulness and the effect of the interactive whiteboard, and its impact, on my students’ learning. The board has been described as an interactive tool of which the students and teacher may collaborate in the teaching and learning process (Bell 2000). Witnessing first hand the everyday motivational affects of the board on my students, the justification for my continued use of the board, and its impact on my students’ achievement, has led to an increased curiosity surrounding the interactive electronic whiteboard. I witnessed first hand how better prepared and smooth-flowing my daily lessons were when I used the board. Students commented that they enjoyed class more when I used the board, with some remarking that math had “made sense” to them for the very first time and that they could understand and “see” (a term that was often thrown around) the math better. As I gained greater interest in the boards use, and saw unmotivated students score higher than they previously had, thoughts surrounding educational research with the board’s use began to surface. This has led to the following research questions:

Research Question One

Will the use of the interactive electronic whiteboard increase students’ achievement as demonstrated by performance on a pre and post mathematics test?
Research Question Two

Will use of the interactive electronic whiteboard increase students’ visualization skills as demonstrated by performance on a pre and post test of Wheatly’s Spatial Ability Test?

Research Question Three

What are the mediating factors of the interactive electronic whiteboard in improving students’ attitudes towards use of technology in the mathematics classroom, as determined by clinical interviews?

Research Question Four

What is the nature of the interactive electronic whiteboard’s role in having an impact on students’ attitudes towards the teaching and learning of mathematics, as determined by clinical interviews?

Assumptions

1. Students of all participating classes will resemble the general student population of the State of Florida. The demographics of the student body at Florida State University School resemble the demographics of school sites in the State of Florida in the areas of gender, ethnicity, and students who receive free and reduced lunch.

2. The use of the interactive electronic whiteboard will be the only variable between the set of experimental classes and control classes (use of the computer, lcd projector, and students’ tests will remain constant.)

3. Students will give honest opinions and statements in clinical interviews and will perform to the best of their ability on pre and post tests.

Limitations

1. The representative sample will include only two classes (of approximately thirty-five students each) from one middle school in the State of Florida.

2. The pre and post mathematics tests will be designed by the publishers of the student’s seventh grade mathematics textbook.
3. The curriculum taught will be based on Florida’s Sunshine State Standards and the course’s approved textbook.

4. Only one brand of interactive electronic whiteboard will be used in the study (results from the study should carry over to other brands of interactive electronic whiteboards).

5. Students will be subject to other computer instruction (including other computer peripheral teaching tools) throughout other classes which may influence their attitudes and the impact of the interactive electronic whiteboard in their mathematics class.

**Definition of Terms**

*Interactive Electronic Whiteboard*

The interactive electronic whiteboard is a device that interfaces with a computer. “The computer images are displayed on the board where they can be viewed or manipulated. Users can control software both from the computer and from the board. Notes can be added, points of interest highlighted, and programs manipulated as one would on a giant touch pad. Resulting notes, drawing, etc. can then be printed out [or loaded to a website] from the computer or saved for future reference” (Bell, 2000). The SmartBoard interactive electronic whiteboard will be used in this study. “SmartBoard” is a brand-name interactive electronic whiteboard produced by SMART Technologies, Inc.

*LCD Projector (Liquid Crystal Display)*

The LCD Projector enables a video image (from a computer, television, video cassette recorder or similar device) to be projected, allowing an audience to see a larger version of the typical image, as compared to the computer monitor or television screen.

*Peripherals*

Computer related devices that are hooked to the computer via cables, increasing the input and output capabilities of the standard computer.
CHAPTER 2

REVIEW OF LITERATURE

*The Interactive Electronic Whiteboard*

The interactive electronic whiteboard system is composed of three parts: a computer, an lcd projector, and the interactive whiteboard system itself. Each aspect of this system is vital, and the full effects of the interactive whiteboard can not be exploited without the computer or the lcd projector. The typical setup of the interactive electronic whiteboard is shown in Figure 1, adapted from Cheetham’s (2003) diagram of the operator/software interface. A variety of models of interactive electronic whiteboards are manufactured by numerous technology companies, including SMART Technologies, Polyvison, IPD-Numonics, Hitachi, Plus Corporations, Promethean, and others (Weiser, 2001). Canada’s SMART Technologies Smart Board is estimated to dominate nearly fifty percent of the interactive white board market (Holloway, 2001) and was first developed in 1986. Various competitors’ interactive electronic whiteboards offer many of the same features as the SMART Board (which will be used in this study), with minor differences in appearance and price (Weiser, 2001).

*Figure 1. Typical Setup of the Interactive Electronic Whiteboard*
The interactive electronic whiteboard surface is touch sensitive, and acts as a giant touch screen display. “Two sheets made of resistive material are separated by a 20-millimetre air gap. The sheets have electrical conductive properties, so when one sheet gets pressed onto the other, it maps the x,y coordinates and matches them against the computer screen,” (Holloway, 2001), enabling a teacher or student to “write” on the board with a pen stylus (similar to those used on personal data devices such as a Palm Pilot) or with their finger. The IT Learning Exchange (2003) comments, “as with all technology, it’s how it’s used, not the technology itself, that will ultimately determine its value for teaching and learning.”

**A Tool for Teaching**

First introduced for business and video conferencing purposes, the interactive electronic whiteboards have gained popularity in educational settings, from K-12 schools to the collegiate level (Bell, 2000). Users of the whiteboards have claimed that the boards have the potential to greatly enhance education, allowing the teacher to record class notes, prepare lessons in advance, utilize the internet and integrate numerous software programs to be used in the classroom for whole class instruction (Reardon, 2002; Gage 2002; Bell 2002). The interactive electronic whiteboard’s ability to turn one classroom computer into a “powerful learning tool” (Wilson, Jones & Hall, 2003) has perked the interest of educators concerning this emerging technology. With the use of vivid color, different fonts, integrated web pages and applets, presentation software, and scanned images, the classroom teacher’s lectures or presentations are turned into a multimedia, dynamic experience (Fernadez & Luftplass, 2003).

Software such as Microsoft’s PowerPoint, SMART Technologies’ SMART Notebook, or Promethean’s ACTIVStudio can be used in preparation for a teacher’s lesson. A slide show feature, used in PowerPoint, allows for organization of a teacher’s lesson from one point or concept to another. The SMART Notebook and ACTIVStudio’s main feature, a flipchart-like space for notes to be written upon and easily navigated between allows for a constant fresh “board space”, as compared to the traditional blackboard, which must be completely erased when no room for writing remains. Teacher’s lessons are more organized, thought-out, and develop more of a natural flow as
more time must be spent preparing and mapping out lessons to construct slides and flipchart pages (Bell, 2002). However, because notes written on the board can be saved for future use, a teacher’s initial preparation can be utilized for years to come (Bell, 2002).

**Student Achievement**

As new technology emerges, questions will inevitably arise as to the educational benefit of the new technology. Such is the case with the use of the interactive electronic whiteboard. Do students learn more as a result of the board’s use? Do students retain more knowledge? Do students learn in a different manner because of the teacher’s use of the board? These questions and others have been researched throughout the world. Linda Tate’s (2002) community college research and Mary Ann Bell’s (2000) middle school research regarding the impact of student learning gains as a result of the use of the interactive electronic whiteboard show no statistically significant difference in learning gains among experimental and control classes. Tate’s research, in college level English classes, and Bell’s research, in middle school writing classes, is the most in-depth research found that examines students’ learning gains.

Examining uses in a foreign language class, Gérard, Widener, and Greene (1999) report that student gains in visual and auditory aspects of a foreign language have increased as a result of the interactive whiteboard’s use. As oral skills and cognitive processes were examined, Gérard et al. found students’ skills in these areas were positively affected. The investigation of the board in other subjects (reading, writing, and science) and grade levels, such as primary British Schools (SMART Project, 2002; Smith, 2000), middle schools (SMART Project, 2002; Bell 2000), two British secondary schools (Levy, 2002), and college level (Tate, 2002; McAllen, 2002), have related teachers’ perceived learning gains of their students, but few of the studies (excluding Bell, 2000 and Tate, 2002) have measured students’ actual learning gains.

**Student Attitudes**

While limited research exists into student learning gains, other gains experienced by students have been investigated. Fernandez and Luftglass (2003) suggest that
“interactive whiteboards can be a powerful tool to further create a dynamic learning atmosphere for the student.” That dynamic learning atmosphere has the ability to foster positive attitudes of students towards learning. Sciefele and Csikszentmihalyi (1995) have related that student motivation and ability, as factors in the overall mathematics experience and the student’s mathematical achievement, are important aspects of learning. The process of learning is enjoyed to a greater degree as a student’s motivation increases, and in turn their academic knowledge is retained longer (Sciefele & Csikszentmihalyi, 1995). Studies have shown that the use of technology in middle school technology classes (Smith, 2000), general primary grade classes (Levy, 2002), Community College history classes (Tate, 2002), and middle school writing classes (Bell, 2000), that include the interactive electronic whiteboard, causes an increase in student motivation. Student reactions to the use of technology are overwhelmingly positive (Knight, 2003) and the students’ attention is increased (Knight, 2003; Tate, 2002; FERL, 2003) and learners exhibit increased motivation and enjoy the interaction that the interactive electronic whiteboard offers (FERL, 2003). As students exhibit greater motivation, their ability to learn and retain knowledge is increased.

Although students’ motivation levels may increase as a result of the interactive whiteboard’s use, researchers have commented on negative aspects of the board and its practically. The cost of the interactive electronic white board ranges from $1,500 to over $30,000 (Fernandez & Luftglass, 2003), often not including a required computer or lcd projector. Further, once the boards are obtained, many teachers are allowed access to the boards without training, allowing for misuse or lack of use (Bell, 2002; Dye, 2003). With a new piece of technology sitting in the corner of the room, unused by a teacher, Dye (2003) comments that students reactions to technology and its usefulness in learning will be negatively affected.

The novelty of the whiteboard is apt to create increased interest for any student in a traditional classroom (Knight, 2003). However, Knight also suggests that once this “novelty” of using the board wears off, students’ positive reactions and increased motivation may subside. Only further research as to the lasting affects of the prolonged use of the board can answer this question. Smith (2000) also draws a similar conclusion
that “whiteboard fatigue” may occur on the part of the student as use of the board increases across classrooms.

Motivation is a factor that researchers have observed at various grade levels. Community college students who had access to technology in their classrooms reported that the more technology was used in a class, the more useful that piece of technology (including the interactive electronic whiteboard) appeared (McAllen, 2001). Classes without the technology were perceived as less helpful. Because of its perceived usefulness, Tate (2002) found students retention and interest in a class, as well as overall motivation in learning, increased. Younger students have also exhibited increased motivation and interest through learning in a first grade classroom, (Solvie, 2001), as well as middle school students reporting greater attitudes of motivation and interest in a history class (Weimer, 2001). The generalizability of the interactive electronic whiteboard as a tool for increasing students’ motivation and attitudes towards learning spans ages and grade levels, and promises impact at every level.

Visualization

With classroom attention directed at such a powerful medium for relating information to students, or collaborating with students to learn new information, the visual aspects of the board (colors, precisely drawn shapes, highlighting) help to increase the students motivation and attention, as well as capture material in a way such that they hopefully retain it longer (Knight, 2003; Ball, 2003). The visual nature of the board, and its appeal to both students and teachers because of this factor, is apt to raise questions as to the board’s impact on a student’s visualization skills in a mathematics classroom. “Today’s child is a visual child…” says Ausburn and Ausburn in 1978, “…and visual communication technologies had tremendous new teaching and information transmitting potential.” (Ausburn, 1978, as cited in Clements, 1981). Twenty-five plus years later, the same can be argued. Presmeg (1986) defines the terms “visual presentation” (a method of teaching which involves formation and use of visual imagery by the teacher or pupils or both) and “teaching visually” (a mathematics teacher’s teaching visually is the extent to which that teacher uses visual presentations when teaching mathematics). The
interactive electronic whiteboard, in this regard, allows for a visual presentation to be enhanced as the mathematics classroom instructor teaches visually.

The Wheatley Spatial Ability Test (Wheatly, 1996) measures “mathematics potential” and the visualization skills of a student. In numerous studies (1992, 1997, 1998) Wheatly has observed and created models for improving the visualization sense of students in the teaching and learning of geometry and transformations. Through hands on activities, the interaction between the teacher and students has promoted the students’ gain in visualization (Wheatly, 1997). Wheatley argues that when students are encouraged and provided the opportunities to form mental images, most do. Consequently, when these students are encouraged to use imagery their mathematical power is greatly increased (Wheatley, 1991). While visualization skills may increase, mathematical ability and skill may also increase. Sowder and Juilfs’ 1980 study of seventh grade students and the use of “imagery-inducing manipulatives” found that achievement by these students in mathematics significantly interacted with an imagery-inducing manipulative treatment and a more abstract symbolic treatment. Students with low pretest scores on mathematics tests received higher scores on the achievement posttest when instruction included manipulative materials, whereas students with high pre-treatment test scores found the symbolic treatment more beneficial (Sowder and Juilfs, 1980, as cited in Clements, 1982). While research has occurred in the areas of promoting visualization in mathematics students, using visual means of teaching, and forming tests and measures of visualization skills, the interactive electronic whiteboard’s role in promoting visualization skills in students, especially in the teaching and learning of transformations in mathematics, has yet to been directly investigated.

Uses in Mathematics

Mathematics, at times a very visual core subject required of students at almost every grade level, has garnered some interest in its relation to the teaching and learning using the interactive electronic whiteboard. Geometric terms, pictures, and concepts, along with charts and graphs, when displayed and manipulated on the whiteboard, seem to pique students’ interest and curiosity while promoting a greater depth of understanding (Ball, 2003). As these concepts are explored, Ball reports that students have related that
they are more interested, enjoy learning more, and have an easier time understanding material, as described in interviews with students who were subjected to the board’s use in their math class.

Richardson (2002) draws the same conclusions as Ball regarding students level of interest and understanding while using the interactive electronic whiteboard in her classroom, adding that her own level of questioning, and the insight and depth of student responses, have increased because of the interactive, visual nature of the board. As students learning is “enhanced”, their self-esteem and sense of achievement regarding mathematics increased (Richardson, 2002). Teachers’ levels of self-esteem and attitudes surrounding mathematics have also increased, with one calling the interactive whiteboard “a revolution for mathematics teaching” (Miller, 2002). Miller describes that the combination of dynamic software, such as Microsoft Excel and Geometer’s Sketchpad, has allowed for innovative teaching methods to be developed by technology infused teachers.

The practical applications of the interactive whiteboard’s use in the mathematics classroom has prompted some educators to design unique curriculum and units where the power of the interactive whiteboard can be exploited (Barton, 2003; Edwards, Hartnell & Rosalind, 2002). The geometric concepts of transformations, including rotations, translations, reflections and dilations, have provided a focal point for the board’s use, an “obvious medium for teaching and learning about transformations” (Edwards, Hartnell & Rosalind, 2002). Barton (2003) also investigates the board’s interactive ability to complement the teaching of transformations with the software programs Microsoft Excel and Geometer’s Sketchpad. The continuing interest in using the board as a teaching tool, for a variety of mathematics subjects, still beckons further research.

**Ongoing Studies**

As the relatively new interactive technology continues to be developed and researched, numerous ongoing studies exist that seek to discover the educational impacts of interactive electronic whiteboards. While these studies and their researchers have not yet drawn definitive conclusions, their work promises to have important implications towards teaching and learning. Regarding teachers’ use of the interactive whiteboard as a
tool for learning, Micromath’s Interactive Whiteboard Working Group (2003) is developing teacher tested activities to be used with the whiteboard throughout various subjects in classrooms spanning all grade levels. These activities, sought to be released on CD-ROM in late 2004, will provide classroom teachers with a valuable resource for lesson planning and creative, engaging ideas for use in their classrooms. Interactive activities are also currently being developed by software developers of SMART Technologies and Promethean, Inc.

While classroom resources continue to be developed, ongoing research around the world seeks to investigate the educational impact of interactive electronic whiteboards. The REvIEW Project (Research and Evaluation of Interactive Electronic Whiteboards) began in 2002 at the University of Hull (Scarborough, England) to identify effective practice of the board’s use. The Smart Board Project (2004), originating at the California Institute of Technology, in collaboration with researchers at the University of Otago (New Zealand) and Brown University, are committed to developing methods for computer-assisted exploration and instruction in mathematics and computer science via the interactive electronic whiteboard. As new instructional methods are developed, further technology developing is occurring with the DEBBIE (DePauw Electronic BlackBoard for Interactive Education) system’s development, allowing individual students in a classroom to write own their own personal desktop interactive electronic whiteboard, whose image may them be projected to the entire class. Further technological advancements to existing interactive electronic whiteboards, including larger screen areas and the ability for more than one user to write on the board at once are being developed at the Tokyo University of Agriculture and Technology (Otsuki, Bandoh, Kato, & Nakagwa, 2000).

As effective teacher practice and technology advancements are being investigated, the University of Wales Institute at Cardiff’s development of a technology-infused teacher education program (Cheetham, 2003) seems the most promising in informing and training new teachers as to the pedagogical, practical, student-centered benefits of the interactive electronic whiteboard’s use. However, other areas of the interactive electronic whiteboard’s use call for immediate research. As highlighted, papers have been written describing the board and its uses, while few studies have measured both student learning
gains and students’ attitudes towards the boards. Studies that have done this (Bell, 2002; Tate, 2002), but have not delved into the middle school mathematics student’s gains and perceptions of the board, nor the board’s effect on student’s attitudes towards mathematics, technology, or learning in general. While educators have commented on the boards’ ability to “revolutionize mathematics” and the teaching of transformations (Miller, 2002), no studies have been conducted that investigate the student’s learning gains of the subject matter or gains on visual and spatial tests, leaving a wealth of information to be researched and reported to the educational community.
CHAPTER 3

METHOD

Experimental Design

The investigation of the stated research problems took place during a six day period at Florida State University School in Tallahassee, Florida. During these six days, a unit covering geometric transformations, including symmetry, reflections, rotations, and translations was taught by the researcher (who was also the students’ mathematics teacher). A pretest and posttest was given in order to measure the change in student achievement over the time of the presented lessons and teaching. A second pretest and posttest was given in order to measure the change in student visualization skills. Finally, clinical interviews were conducted with students in order to gain insight into their attitudes and motivations towards mathematics and learning as a result of the use of the interactive electronic whiteboard. Internal validity was enhanced by all of the students coming from the same middle school, having the same teacher for their mathematics class, and being heterogeneously grouped and scheduled for their respective classes based on the school’s typical scheduling patterns.

Population and Sample

Students selected for the experimental and control groups of the study were a part of the seventh grade class of Florida State University School. The school has one hundred and sixty two students enrolled in the seventh grade, who reflect the demographics of the State of Florida, and one hundred and sixty of these students were taught general seventh grade mathematics by the researcher, spread out among five class periods. The researcher’s fifth and sixth period classes (out of a seven class period day) were subjects in the study. The fifth period class had twenty-eight students \((n = 28)\) and the sixth period class had thirty-three students \((n = 33)\).

Both classes taught by the researcher had been exposed to the use of an interactive electronic whiteboard since January 2004 (research was conducted during the last week
of April 2004). The board was used daily by the researcher and his students during these four months. Throughout this research the experimental group shall reference the period of students who are receiving the treatment of classes being taught without the interactive electronic whiteboard. The control group of students are those being taught in an ongoing, standard manner, with the use of the interactive electronic whiteboard that they had become accustomed to. The researcher’s fifth period seventh grade mathematics class was taught using the interactive electronic white board (the control group), while his sixth period seventh grade mathematics class was taught without the use of the board (the experimental group).

**Materials**

The experimental class will have access and will use the following:

- Interactive electronic whiteboard
- LCD Projector
- Computer
- Internet connection
- Geometer’s Sketchpad Software
- Microsoft PowerPoint Software
- SMART Notebook Software

The interactive electronic whiteboard that will be used for this study will by the 72-inch (diagonal) SMART Board on a rolling stand. A Compaq Presario 2100 Series laptop computer running Microsoft Windows XP will be connected to a Toshiba LCD Projector, Model 1210, projecting 1100 lumens. A live T1 speed internet connection will be used for internet access. Software programs, including Geometer’s Sketchpad version 4, Microsoft PowerPoint 2003, and SMART Notebook build 8.1.1.24 will be used for lesson presentations. The SMART Board is a permanent fixture of the researcher’s classroom (not being shared or moved) and is located in the room according to the diagram in Figure 2 below.
Figure 2. Setup of classroom for both the control and experimental classes.

Instrumentation

Transformations Unit Pretest and Posttest

Two pre-made tests taken from Scott Foresman’s Middle School Math: Course 2 textbook, published by Addison Wesley (1998), will be used to measure the change in student achievement over the course of the presented lessons and teaching (Appendix I). The pre-made supplemental test book includes five versions of a test covering transformations from the book’s eleventh chapter. One test was selected from the five versions, to be used for both the pretest and the posttest. Students took the pretest, being allowed as much time as they needed during a fifty-minute class period, the first day of the transformations unit. The tests were scored by the researcher, and each question was graded either correct or incorrect. No partial credit was awarded. The students’ overall percentage of correct responses served as their Transformations Pre Test score. Students took the posttest, being allowed as much time as they needed during a fifty-minute class period, during the sixth and final day of the transformations unit. The tests were scored by the researcher, and each question was graded either correct or incorrect. No partial credit was awarded. The students’ overall percentage of correct responses served as their Transformations Post Test score.
Wheatley Spatial Ability Test

Grayson Wheatly’s Spatial Ability Test Form B (1996) was given as a pretest and a posttest to measure the change in the students’ spatial and visualization learning gains as a result over the time of the presented lessons and teaching. Students took the pretest, being allowed as much time as they needed during a fifty-minute class period, the first day of the transformations unit. Tests were scored by the researcher according to the recommended standard scoring scheduled as described in the test overview (Appendix II). Students took the posttest, being allowed as much time as they needed during a fifty-minute class period, the sixth and final day of the transformations unit. Tests were scored by the researcher according to the recommended standard scoring scheduled as described in the test overview (Appendix II).

Clinical Interviews

Clinical interviews were conducted shortly after the six day transformations unit with four students, two from the experimental class (sixth period) and two from the control class (fifth period). Subjects were purposefully sampled based on the researcher’s observation of students in both classes, with the intention of interviewing students who demonstrated a sharp awareness to mathematics learning and an ability to verbally relate their thoughts and actions. The aim of the interviews was to elicit honest responses from students in the control group (those who had use of the interactive electronic whiteboard) as well as students in the experimental group (those who were not involved with its use) to compare their responses. The interviews purpose was to delve into the students’ thoughts concerning their motivation levels and attitudes revolving around learning mathematics and learning in general. Observations recorded by the researcher during the teaching of the transformations unit were used as basis of questioning the students. Students were questioned initially as to what they thought the interactive electronic whiteboard was (giving a definition), describing its uses, if they noticed whether or not it was being used, discussing their thoughts about the board in relation to learning mathematics, discussing their thoughts about the board in relation to motivation in the mathematics classroom, to other uses of the board not explored by the researcher. Students’ responses were further questioned to elicit more in-depth
understanding by the researcher. Results from these interviews can be transferred to other situations due to the representative sample of all seventh graders from which the interview subjects will be selected.

**Lesson Design**

The presented lessons taught during the six day transformations unit were planned by the researcher with the collaboration of his experienced major professor. Ideas from internet sources and the teacher’s addition of the course textbook (Foresman, 1998) were used in planning each day’s lessons. Students were given pre tests on day one, with subsequent days focusing on the topics of translations, symmetry, reflections, rotations and a review of transformations (respectively). Lessons taught during the fifth period control group classes were taught with the use of the interactive electronic whiteboard. Notes were written on interactive electronic whiteboard, computer navigation and actions were control from the board, and use of SMART Technology’s SMART Notebook software was controlled via the board to show translations and rotations. Figures were able to slide across the board or turn in various positions with the use of a students’ fingers on the touch sensitive interactive electronic whiteboard. All lessons presented during the sixth period experimental classes were taught without the use of the interactive electronic whiteboard. The board did remain in the teacher’s classroom as moving it each day to a new location out of students’ sight would have been time-consuming and nearly impossible. Any computer programs that were used in the control class were also used in the experimental class. The only variable occurred with the surface the board was projected onto; in the control class the projection was onto the interactive electronic whiteboard, while the projected computer images were displayed on a hanging overhead screen in the experimental classes. A student was selected to control a mouse from the computer’s location when navigation and computer action was needed (as opposed to a student being called to the interactive electronic whiteboard during the control class to perform the same action). Smart Technology’s SMART Notebook was also used in the experimental class with student mouse control rather than hand-board control in the fifth period control class.
An action research design was used in teaching and preparation of the six day transformation unit. The term “action research” is used as a label for classroom investigations undertaken by teachers. It is a form of self-reflection inquiry which encourages teachers to be aware of their practices, and to be prepared to change it. (McNiff, 1988). The role of a practicing teacher undertaking action research is teacher-as-researcher.

An important component of an action research paradigm is the colleague who serves as the co-investigator and critical friend to the primary teacher-researcher. This person assists in the planning, implementation and evaluation stages of the project. This person serves as an observer of classroom practices and acts as a catalyst for reflections on pedagogical behaviors. Frequently in the process of conducting action research, the teacher-researcher gains new insights into the project that may lead to changes in prescribed procedures. In scientific research, such insights would be applied to later research projects, but in action research the procedure is usually changes while the project is in progress. Because the teacher-researcher is participating in the classroom, enthusiasm and ego-involvement can lead to biasing and reducing the generalizability of research findings. For this reason, the co-investigator or observer-researcher, the researcher outside the situation, remains objective and unbiased lending more credibility to the generalization of results (Borg, 1963). The teacher-researcher’s major professor served as the critical friend, lending insights and ideas into lesson planning and preparation, offering notes, observations, and insights into student’s behavior during each class period while helping to maintain internal validity and ensure the only variable that existed in the research design and lesson presentation was the use of the interactive electronic whiteboard.

**Procedures**

*Level of Consent*

Permission to conduct this experiment was first obtained from the Research Director of Florida State University School. Human Subjects Approval had been granted by the Florida State University, with participants being fully informed of any risk they may encounter as a result of the study. Students in each class were required to return a
signed permission form to take part in the study. Students also had the opportunity themselves to declare their understanding of the study and consent to proceed as a subject of the study, with no penalty towards their grade had they elected not to proceed.

Implementation of the Study

The study was conducted during the third week of April, 2004. Lessons were presented each day during the fifty minute fifth and sixth period classes taught by the researcher. The presentation of the lessons occurred with variability only existing in the use of the interactive electronic whiteboard. Computer software programs, internet websites, and demonstrations made with the computer in the experimental class were projected using the lcd projector onto an overhead screen. Pretests were given on the first day of the six day transformations unit, and posttests were given on the sixth and final day of the transformations unit.

Data Analysis

The statistical software package Minitab 12 was used for data analysis procedures. Student pretest and posttest scores from the textbook tests were scored by the researcher, with a percentage of correctly answered questions constituting an overall percentage of the questions answered correctly. The students’ transformations pre and posttest scores were compared to establish learning gains as a result of the interactive white board’s use. The student’s learning gain scores were computed by taking the difference between their post and pre test and dividing that difference by the difference of one hundred percent and the student’s pre test score (learning gain = \( \frac{\text{posttest} - \text{pretest}}{100 - \text{pretest}} \)). The learning gain scores were compared for the control and experimental groups.

Student pre and post test scores from Wheatly’s Spatial Ability Test (WSAT) were scored by the researcher according to Wheatly’s recommendation in the test overview guide (Wheatly, 1996). The students’ pre and posttest scores were compared to establish visual and spatial learning gains as a result of the interactive white board’s use. The students’ WSAT pre and posttest scores were compared to establish learning gains as
a result of the interactive white board’s use. The student’s learning gain scores were computed by taking the difference between their post and pre test and dividing that difference by the difference of one hundred percent and the student’s pre test score (learning gain = \( \frac{posttest - pretest}{100 - pretest} \)). The learning gain scores were compared for the control and experimental groups.

Once all scores were recorded, a two-tailed t-test of significance was used to compare means of learning gains for the transformations test and WSAT test. A level of significance for the found p values were set at 0.05.

Clinical interviews were audio taped and transcribed. The researcher used student’s insights and information gained from the clinical interviews in order to generalize students’ attitudes and motivation regarding the use of the interactive electronic whiteboard in a mathematics class and towards learning in general. The researcher’s observations, as well as observations made by the researcher’s major professor (the critical friend) were used for the same purpose.
CHAPTER FOUR

FINDINGS

Research Questions

This action-research study was designed to determine the impact of the interactive electronic whiteboard in middle school mathematics. The researcher taught two seventh grade mathematics classes during a six day unit on transformations: translations, reflections, and rotations. The control class had access to the use of the interactive electronic whiteboard (as both classes had been exposed to it in their class for three months prior to the research study) while the experimental class was taught without the use of the interactive electronic whiteboard. The sole independent variable was the use of the interactive electronic whiteboard (and lack of its use) in each class. Pre and post tests were given to measure the students’ change in visualization skills and content knowledge over the course of the instruction, while interviews with four students, two in each class, were conducted to investigate the nature of the interactive whiteboard and its impact in a middle school mathematics classroom. The research questions investigated in this study were:

Research Question One

Will the use of the interactive electronic whiteboard increase students’ achievement as demonstrated by performance on a pre and post mathematics test?

Research Question Two

Will use of the interactive electronic whiteboard increase students’ visualization skills as demonstrated by performance on a pre and post test of Wheatly’s Spatial Ability Test?

Research Question Three
What are the mediating factors of the interactive electronic whiteboard in improving students’ attitudes towards use of technology in the mathematics classroom, as determined by clinical interviews?

Research Question Four

What is the nature of the interactive electronic whiteboard’s role in having an impact on students’ attitudes towards the teaching and learning of mathematics, as determined by clinical interviews?

The research was conducted during the last week of April 2004 at Florida State University School in Tallahassee, Florida. The researcher’s fifth and sixth period seventh grade mathematics classes were used as a part of this study. The fifth period class, with twenty-seven students, was used as the control class who had access to the use of the interactive electronic whiteboard in all lessons that were presented throughout the study. The sixth period class, with thirty-three students, was used as the experimental class who did not have access to the use of the interactive electronic whiteboard in any lessons that were presented throughout the study.

Results

Research Question One

Will the use of the interactive electronic whiteboard increase students’ achievement as demonstrated by performance on a pre and post mathematics test?

Throughout the six day mathematics unit on transformations, students were taught the concepts of a translation, symmetry, reflections, and rotations, aligned with Florida’s Sunshine State Standards and seventh grade mathematics’ Grade Level Expectations. Assessment material from the course textbook, Scott’s Foresman’s Middle School Mathematic: Course 2 was used as the pretest and posttest. Students were given the same test from the assessment material (Appendix A) for the pre and post test to measure their gain in transformations content knowledge as a result of the use of the interactive electronic whiteboard. Students’ pretests and posttests were both graded by the
Each question was given full or no-credit based on the correct response. Individual student scores for both class periods are shown in Figure 3 and Figure 4.

**Figure 3.** Transformations Pre and Post Test Score Comparison for Control Group.

**Figure 4.** Transformations Pre and Post Test Score Comparison for Experimental Group.
Students with a zero on a pre test or post test, in either class, were not present on the first or sixth day of the transformations unit (when the pre and post tests were given, respectively). In the control class, one student scored the same on both the pre and the post test, while all other students increased their score. In the experiment class, two students scored the same on both the pre and post test, while all other students increased their score.

The students’ learning gain scores were computed by taking the difference between their post and pre test and dividing that difference by the difference of one hundred percent and the student’s pre test score (learning gain = \(\frac{\text{posttest} - \text{pretest}}{100 - \text{pretest}}\)).

Student learning gain scores are summarized in Table 1.

Table 1

*Transformations Unit Test Learning Gains*

<table>
<thead>
<tr>
<th>Class</th>
<th>Sample Size (n)</th>
<th>Mean Learning Gain (µ)</th>
<th>Standard Deviation (σ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5th Period (Control)</td>
<td>18</td>
<td>0.56</td>
<td>0.311</td>
</tr>
<tr>
<td>6th Period (Experimental)</td>
<td>28</td>
<td>0.46</td>
<td>0.222</td>
</tr>
</tbody>
</table>

Student learning gains did increase in both the control and experimental classes. Sample size was determined by the number of students who took both the pre and post tests. The number of students enrolled in fifth period was twenty-seven and the number of students enrolled in sixth period was thirty-three. With a difference in sample sizes, a two-tailed t-test was used to compare the statistically-significant differences in the mean learning gain in the control and experimental classes. The statistical analysis software program Minitab 12 was used for data analysis procedures. The null hypothesis (\(H_0: \mu_1 = \mu_2\)) declared the mean learning gains among the two classes were equal, while the alternative hypothesis (\(H_1: \mu_1 \neq \mu_2\)) declared the mean learning gains among the two
classes were not equal. A p-value of 0.05 was set to determine the statistical significance of the difference in the mean learning gains. If a p-value less than 0.05 was found, the null hypothesis would be rejected, and a statistically significant difference in the mean learning gains would be shown. If a p-value greater than 0.05 was found, the null hypothesis would be accepted, and a statistically significant difference in the mean learning gains would not be shown. The transformations unit test mean learning gains comparison, with the results of data analysis, are summarized in Table 2.

Table 2

*Transformations Unit Test Mean Learning Gains Comparison*

<table>
<thead>
<tr>
<th>Source</th>
<th>T-Value</th>
<th>P-Value</th>
<th>Degrees of Freedom</th>
</tr>
</thead>
<tbody>
<tr>
<td>T-test for Difference in Means</td>
<td>1.19</td>
<td>0.244</td>
<td>28</td>
</tr>
</tbody>
</table>

The calculated p-value of 0.244 is greater than the set significance level p-value of 0.05. The null hypothesis, that the mean learning gains of the control and experimental classes are statistically equal, is not rejected.

*Research Question Two*

Will use of the interactive electronic whiteboard increase students’ visualization skills as demonstrated by performance on a pre and post test of Wheatly’s Spatial Ability Test?

Throughout the six day mathematics unit on transformations, students were taught the concepts of a translation, symmetry, reflections, and rotations, aligned with Florida’s Sunshine State Standards and seventh grade mathematics’ Grade Level Expectations. Grayson Wheatley’s Wheatley Spatial Ability Test (WSAT) Form B (Appendix B) was used to measure the students’ gain in spatial visualization skills as a result of the use of the interactive electronic whiteboard. Students’ pretests and posttests were both graded
by the researcher according to Wheatly’s prescribed standard of grading in the test administration manual (the students score out of 100 points is based on the total number of question they answered minus one half the number of questions the answered incorrectly). Individual student scores for both class periods are shown in Figure 5 and Figure 6.

![5th (Control) WSAT Pre & Post Test Score Comparison](image)

**Figure 5.** WSAT Pre and Post Test Score Comparison for Control Group
Students with a zero on a pre test or post test, in either class, were not present on the first or sixth day of the transformations unit (when the pre and post tests were given, respectively). In the control class, two students had a higher test pretest score than post test score, while all other students increased their score from the pretest to the posttest. In the experiment class all students increased their score from the pretest to the posttest.

The students’ visualization gain scores were computed by taking the difference between their post and pre test and dividing that difference by the difference of one hundred percent and the student’s pre test score (visualization gain = $\frac{\text{posttest} - \text{pretest}}{100 - \text{pretest}}$).

Student visualization gain scores are summarized in Table 3.
Student visualization gains did increase in both the control and experimental classes. Sample size was determined by the number of students who took both the pre and post tests. The number of students enrolled in fifth period was twenty-seven and the number of students enrolled in sixth period was thirty-three. With a difference in sample sizes, a two-tailed t-test was used to compare the statistically-significant differences in the mean learning gain in the control and experimental classes. The statistical analysis software program Minitab 12 was used for data analysis procedures. The null hypothesis ($H_0: \mu_1 = \mu_2$) declared the mean visualization gains among the two classes were equal, while the alternative hypothesis ($H_1: \mu_1 \neq \mu_2$) declared the mean visualization gains among the two classes were not equal. A p-value of 0.05 was set to determine the statistical significance of the difference in the mean visualization gains. If a p-value less than 0.05 was found, the null hypothesis would be rejected, and a statistically significant difference in the mean visualization gains would be shown. If a p-value greater than 0.05 was found, the null hypothesis would be accepted, and a statistically significant difference in the mean visualization gains would not be shown. The Wheatley Spatial Ability Test mean visualization gains comparison, with the results of data analysis, are summarized in Table 4.

Table 3

**Wheatley Spatial Ability Test (WSAT) Visualization Gains**

<table>
<thead>
<tr>
<th>Class</th>
<th>Sample Size (n)</th>
<th>Mean Learning Gain (µ)</th>
<th>Standard Deviation (σ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5th Period</td>
<td>18</td>
<td>0.60</td>
<td>0.324</td>
</tr>
<tr>
<td>(Control)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6th Period</td>
<td>25</td>
<td>0.54</td>
<td>0.300</td>
</tr>
<tr>
<td>(Experimental)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 4

Wheatley Spatial Ability Test (WSAT) Mean Learning Gains Comparison

<table>
<thead>
<tr>
<th>Source</th>
<th>T-Value</th>
<th>P-Value</th>
<th>Degrees of Freedom</th>
</tr>
</thead>
<tbody>
<tr>
<td>T-test for Difference in Means</td>
<td>0.55</td>
<td>0.589</td>
<td>35</td>
</tr>
</tbody>
</table>

The calculated p-value of 0.589 is greater than the set significance level p-value of 0.05. The null hypothesis, that the mean visualization gains of the control and experimental classes are statistically equal, is not rejected.

Research Question Three

What are the mediating factors of the interactive electronic whiteboard in improving students’ attitudes towards use of technology in the mathematics classroom, as determined by clinical interviews?

Throughout the research study, both the research-teacher and critical-friend involved in the study made observation notes and field notes as a reflection of lessons presented during each of the six days. These observations of students in both the control and experimental classes offered insight into students’ attitudes towards technology as a result of the interactive whiteboard’s use in the classroom. Further, four students were interviewed within one week of the completion of the transformations unit to gain insight into their attitudes regarding the use of technology in the mathematics classroom. Two students were purposefully selected from each of the control class and experiment class on the basis of observations and field notes made by the researcher throughout the six day unit. The researcher observed that the two students chosen from the control class (Ashley and Michelle, who had use of the interactive electronic whiteboard), demonstrated a fine understanding of the transformations unit (both had post test scores above 85%) and demonstrated a greater alertness towards learning with the use of the board as evidenced in comments made throughout the classes. Both students were also known by the
researcher as good communicators, of whom articulate responses to interview questions could be elicited. The researcher also observed that the two students from the experimental class (Vernon and Dana, who did not have use of the interactive electronic whiteboard) demonstrated a good understanding of the transformations unit (both had post test scores above 85%) and also seemed to voice the strongest comments and opinions regarding the lack of use of the board throughout the unit. Both students chosen from the experimental class were also known by the researcher to be good communicators, of whom articulate responses to interview questions could be elicited.

The interactive whiteboard system, including a computer, lcd projector, and interactive whiteboard, form the basis of the technology utilized throughout the research study in the control class. The experimental class did not have access to the interactive electronic whiteboard, but did have access to the computer and lcd projector. Students in the control class were much more interested in coming to the board to orient (align) it, as well as apply transformations (translations and rotations) as compared to their peers in the experimental class. Where many students volunteered to come to the interactive electronic whiteboard to apply the transformations of figures, students were observed to be less interested in volunteering to manipulate these same figures with just the mouse behind the computer that was being projected. Some students in the control class came to the board without being called upon to write or draw on it, having to be reprimanded for not following instructions. One of these students, Michelle, repeatedly asked to come to the board: “Ooooh, let me do it, I want to be the one to orient the board, please please please!” while another student commented that Michelle “…is so fascinated with that board. But I am too!”

Throughout the six day transformation unit, one of the interviewed students from the experimental class, Vernon, asked every single day where the interactive electronic whiteboard was and when the class was going to start using it again. Many other students also complained about not having use of the interactive electronic whiteboard as they could not see the writing on the regular dry erase whiteboard, or had to reposition themselves throughout the room to see computer images projected onto a traditional overhead screen. In his interview, Vernon stated that he enjoyed class more when the board was used because he was interested in the interactive electronic whiteboard and he
got to learn “math and also all that technology stuff with the board.” However, when
commenting on taking notes, Vernon stated that notes written on the interactive white
board versus the dry erase whiteboard were pretty much the same, but he thought “it was
better that you didn’t have to use it because you were actually showing us what we need
to know instead of putting it one the board or something. Because on the Smartboard it’s
like you have to copy down stuff all the time and you have to go up there and explain
stuff. But when you write it up there you can follow the problem better.” His comments,
contradictory to some degree, were further explained as he said “On the Smartboard you
would have things written and you write more, but on the whiteboard, you pause and try
to get our attention more and point out what we have to know.”

The “Oh, cool…” factor of the interactive electronic whiteboard was heard time
and time again from students in the control class as the touch-sensitive, interactive nature
of the board was exploited while investigating rotations and translations. Two small
SMART Notebook files were designed by the researcher two allow for direct
manipulation of the created figures. Where translating and rotating occurred as the
researcher or a student dragged his or her hand across the board to transform a shape in
the control class, the experimental class transformed the same shape with a mouse behind
the computer. As these transformations occurred in the control class, students
commented “Woah, woah, woah, how cool” as triangles were translated, “Oh cool, rad,
neato” by another student as figures were translated, and “Oh cool, I want a Smartboard”
as rotational symmetry was demonstrated. Though students in the experimental class
witnessed the same presentations with the use of the computer and the mouse and not the
interactive electronic whiteboard, no mention of the “Oh, cool…” factor of technology
use was ever related.

The importance of the interactive electronic whiteboard in the classroom was
evident in both the control and experimental classes. Remarked Ashley (in the control
class) to a student who was not present on the first day that translations were covered
“You’re not going to be able to understand, yesterday was a seeing day and the
Smartboard helped us all understand and make it fun.” Not only did Vernon ask for use
of the board during the six day unit, other students also commented after thinking the
board was broken “Did you fix the Smartboard yet?” and “Go to Mr. Dexter’s room
(another teacher who uses the Smartboard) and steal or switch yours with his.” One student remarked “I just hate that we can’t use it—who cares about just the computer.”

The first question asked during each of the four interviews was “If you had to tell someone who had never seen or used a Smartboard what is was, what would your response be?” The students’ answers are as follows:

Ashley: “You can go on the internet with it, it’s the piece of cool technology that helps us learn, and it’s fun to touch and activate when you draw on it…on anything you might see on the computer.”

Michelle: “I’d tell them it’s like one of the classroom boards but it’s electric and it runs with the computer and projector and you use artificial markers instead of real ones”

Vernon: “It’s like a big computer…you go and touch it and learn more…you can go on the internet and play DVD’s and it incorporates everything (technology) together. I think that it is cool…when you write on it…you don’t have to keep on erasing and erasing the board, you can just write on there. And it just goes real quick”

Dana: “It’s a square board and you can touch it to go like on the internet and stuff. You don’t have to use the mouse, like, you’re the mouse. If you can use a computer you would love it and know who to do it. It’s just more fun and interesting.”

Each student response highlights in different ways the technology involved with the use of the interactive electronic whiteboard as well as the students’ opinion and attitude towards the use of the board. The board’s integration as a peripheral of other technological, computer related devices (dvd, mouse, and the internet) appealed to each student. The interactive electronic whiteboard’s ability for students to notice to a greater degree the technology around them is one impact of the board’s use. The interactive electronic whiteboard is a simple projection screen without the combined use of other computer technologies, all of which are highlighted because of the board’s use.

Students in the control class demonstrated a greater awareness and more positive attitude towards the use of the interactive electronic whiteboard and technology in general. Students in the experimental group longed for the board’s return to their class
throughout the research study and exhibited lower levels of involvement in lessons throughout the class. They were less interested when only the computer was used with an LCD projector without the interactive electronic whiteboard, negatively affecting their attitudes towards the use of technology in the mathematics classroom.

**Research Question Four**

What is the nature of the interactive electronic whiteboard’s role in having an impact on students’ attitudes towards the teaching and learning of mathematics, as determined by clinical interviews?

Throughout the research study, both the researcher-teacher and critical-friend involved in the study made observation notes and field notes as a reflection of lessons presented during each of the six days. These observations of students in both the control and experimental classes offered insight into students’ attitudes towards the impact of the interactive electronic whiteboard on the teaching and learning of mathematics. Further, four students were interviewed within one week of the completion of the transformations unit to gain insight into their attitudes regarding the teaching and learning of mathematics. Two students were purposefully selected from each of the control class and experiment class on the basis of observations and field notes made by the researcher throughout the six day unit. The researcher observed that the two students chosen from the control class (Ashley and Michelle, who had use of the interactive electronic whiteboard), demonstrated a fine understanding of the transformations unit (both had post test scores above 85%) and demonstrated a greater alertness towards learning with the use of the board as evidenced in comments made throughout the classes. Both students were also known by the researcher as good communicators, of whom articulate responses to interview questions could be elicited. The researcher also observed that the two students from the experimental class (Vernon and Dana, who did not have use of the interactive electronic whiteboard) demonstrated a good understanding of the transformations unit (both had post test scores above 85%) and also seemed to voice the strongest comments and opinions regarding the lack of use of the board throughout the unit. Both students chosen from the experimental class were also known by the
researcher to be good communicators, of whom articulate responses to interview questions could be elicited.

The use of the interactive electronic whiteboard in the control class had become an established routine. Students expected the board’s use and were accustomed to it. Observations made during the presented lessons to the control class related “Ahh-haa” moments of understanding by a student when a light bulb seemed to click as they saw a translation in motion as demonstrated on the board by the teacher or as they were demonstrating it on the board themselves. The researcher heard comments and noticed looks on faces that indicated understanding as a result of the board’s use; one student, Christina, after a lengthy discussion of congruency, finally understood the concept when the researcher asked her to drag (at the interactive electronic whiteboard) one hexagon on to another hexagon. With no overlap visible (both hexagons were constructed on the computer with a degree of transparency) Christina took part in an “Ahh-haa” moment of understanding while interacting with the electronic whiteboard. Similarly, Ashley echoed a praise of thanks to the interactive electronic whiteboard: “Thank you Smartboard, thank you very much” as she partook in an “Ahh-haa” moment during a lesson on symmetry, using the interactive electronic whiteboard to draw lines on symmetry across pictures of faces taken with a digital camera and projected on to the interactive electronic whiteboard via the computer and lcd projector.

Students’ motivation to pay attention and become more involved in critical thinking as the Smartboard was being used led to investigations in class dealing with transformations that were not originally planned by the researcher. During a lesson on reflections, Paul, a fifth period control group student, caught on quickly and desired to navigate to an online reflections applet at the Smartboard. He asked many “what if…” type questions to the class and conjectured how a reflection of a point on the mirror line would look. He was able to quickly manipulate the reflections while interacting with the electronic whiteboard and came to a greater understanding of the concept being presented. At the end of the lesson he remarked “I love math now” while a fellow student commented “Paul was so much more into this lesson today because he got to go draw and come to the board.” Critical thinking and more positive attitudes towards mathematics were also exhibited by Michelle in the control class. As she drew lines on
the interactive electronic whiteboard while investigating the horizontal and vertical symmetry of the letters of the alphabet, which happened to be all uppercase, she asked if the same could be done with lowercase letters. While drawing on the board and rationalizing her line choices she asked this question, which the class in turn investigated; an occurrence that did not take place in the experimental class. However, a student in the experimental class, while being presented with the rotational symmetry of a regular hexagon, shouted and caused the entire class to pause as he proclaimed “I see it!” As the image of the hexagon was projected on to an overhead projector screen, he observed the outline of a “three-d cube” (square prism). As he tried to show the rest of the class what he was picturing in his mind, he stated “It would be easier with the Smartboard, I could just draw the lines on top of the board.” After raising the overhead screen and readjusting the lcd projector’s image on to the dry erase whiteboard, he was able to draw the inner lines on the regular hexagon to create a square prism.

A common theme of more positive attitudes towards mathematics due to the use of the interactive electronic whiteboard arose from interviewing the students in both the control and experimental groups. Students in the control group had access to the use of the board before and during the research study, while students in the experimental group only had access to the use of the board prior to this research study. Students reported two major opinions: they were more interested and paid more attention in their math class when the board was used during their classes, and the students felt they understood the mathematics to a greater degree, causing them to “like” mathematics more (have greater positive attitudes towards teaching and learning of mathematics) when the interactive electronic whiteboard was being used in their class.

Each of the interviewed students, in both the control and experimental classes, reported an increased interest in their class and an acknowledgement that they paid more attention during class when the Smartboard was used. All of the students stated that they would prefer a class in which an interactive whiteboard was used because:

Ashley: “It’s pretty cool to watch and it helps me pay more attention.”
Michelle: “I like it… and would prefer a class with it because just the way it’s used and the fact that it runs by computer rather than a marker and it just has so much more possibilities.

Vernon: “If it is used more, more people enjoy the class. It gives you something to look at, and follow…it just makes the math cool.”

Dana: “It’s just fun to use it, because we do fun things on it. I just like it better…you can do more stuff on it, than on the whiteboard.”

The two students in the control class stated that they did notice the board was missing during the six day transformations unit, but had not thought much about how class would have been different with its use. Their comparison of a class with and without the board comes as result of the board’s prior use in the mathematics class that was used as a part of this research study.

The interviewed students increased motivation and resulting positive attitudes toward learning math complemented increasing positive attitudes towards the math being taught. Commented Ashley: “I can comprehend the math because it [the interactive electronic whiteboard] helps me visualize what happens and how you do it.” Vernon stated: “The Smartboard helps you understand stuff you wouldn’t be able to understand off the board…you can get to what you want and then change it however you want,” and Michelle remarked “we could actually see the, you know, pictures sliding and moving, where as on the dryboard you would have to draw every flip or rotation. I understood what you were teaching and could follow.” All of the students expressed that they liked mathematics as a subject to a greater degree because the interactive electronic whiteboard enabled them to “understand it all much better” (Dana, personal interview, 2004) and that the researcher (their classroom teacher) made it more interesting when he taught, as was the occasion most days with the interactive electronic whiteboard.
CHAPTER FIVE

SUMMARY, CONCLUSIONS, RECOMMENDATIONS

Summary

The purpose of this study was to investigate the impact of the interactive electronic whiteboard in a middle school mathematics classroom. The interactive electronic whiteboard is a new device that does not have a wealth of supporting research evaluating its use and effect upon the teaching and learning of mathematics. This study was initiated to assess the use of the board in a mathematics classroom and determine its impact and effect on student learning gains in mathematical content and visualization skills, students’ attitudes towards the use of technology in the classroom, and students’ attitudes towards the teaching and learning of mathematics. The research study evaluated four research questions that explored the impact of the board in the mathematics classroom:

1. Will the use of the interactive electronic whiteboard increase students’ achievement as demonstrated by performance on a pre and post mathematics test?
2. Will use of the interactive electronic whiteboard increase students’ visualization skills as demonstrated by performance on a pre and post test of Wheatly’s Spatial Ability Test?
3. What are the mediating factors of the interactive electronic whiteboard in improving students’ attitudes towards use of technology in the mathematics classroom, as determined by clinical interviews?
4. What is the nature of the interactive electronic whiteboard’s role in having an impact on students’ attitudes towards the teaching and learning of mathematics, as determined by clinical interviews?

Each research question is summarized below, with findings of the research discussed.
Discussion

Research Question One
Will the use of the interactive electronic whiteboard increase students’ achievement as demonstrated by performance on a pre and post mathematics test?

Research findings did not show that the interactive electronic whiteboard’s use in a seventh grade mathematics class caused greater learning gains on a transformations mathematics test among students in the control class (those who had use of the board) compared to their counterparts in the experimental class (students who did not have use of the board.) The transformations unit pretest and posttest were given on the first and last day of the research study. Both tests were scored by the researcher and given a percentage score of the total number of correct questions answered. A statistical two-tailed t-test was used to compare the mean learning gain scores of the two different classes used in the study which had different sample sizes. This test of comparison showed no statistically-significant difference in the mean learning gain scores of the control and experimental class.

A visual comparison of the student pre and post test scores show a gain in learning among most participants of both the control and experimental classes. However, in the experimental class, more students had no increase in content knowledge as evidenced by a comparison of their posttest and pretest score. Learning gains did occur among both sets of students, though without any statistically significant difference. Learning gains were likely the result of the typical good teaching in both classes as the impact of the interactive whiteboard’s use was not shown to be noteworthy.

Research Question Two
Will use of the interactive electronic whiteboard increase students’ visualization skills as demonstrated by performance on a pre and post test of Wheatly’s Spatial Ability Test?

Research findings did not show that the interactive electronic whiteboard’s use in a seventh grade mathematics class caused greater visualization gains on Wheatley’s
Spatial Ability Test among students in the control class (those who had use of the board) compared to their counterparts in the experimental class (students who did not have use of the board.) A pretest and posttest version of Wheatley’s Spatial Ability Test was given on the first and last day of the research study. Both tests were scored by the researcher and given a percentage score as prescribed by Wheatley’s Spatial Ability Test scoring guide. A statistical two-tailed t-test was used to compare the mean visualization gain scores of the two different classes used in the study which had different sample sizes. This test of comparison showed no statistically-significant difference in the visualization test gain scores of the control and experimental class.

A visual comparison of the student pre and post test scores show a gain in visualization among most participants of both the control and experimental classes. However, in the control class, two students scored higher on the pretest than the posttest. This may have been caused by the students guessing their responses on either one of the tests, or carelessly answering questions in an effort to complete the entire test. Visualization gains did occur among both sets of students, though without any statistically significant difference. Visualization gains were likely the result of the typical good teaching in both classes and greater familiarity with visualization as a result of the mathematics content covered during the research study, as the impact of the interactive whiteboard’s use was not shown to be noteworthy.

Research Question Three

What are the mediating factors of the interactive electronic whiteboard in improving students’ attitudes towards use of technology in the mathematics classroom, as determined by clinical interviews?

The teacher-researcher and critical-friend’s observations, as well as clinical interviews with students in the control and experimental classes were used as a measure to determine the impact of the interactive electronic whiteboard on the students’ attitudes towards the use of technology in their mathematics classroom. The researcher observed, and students reported, a greater degree of interaction in the class when the interactive electronic whiteboard was used. Student participation and volunteering to take part in the
class increased as the interactive electronic whiteboard was used. The novelty of the interaction between the student and a large, prominent piece of technology in the mathematics classroom may be attributed to the increase in participation and positive attitudes towards the technology. Students’ reflections of the board’s use related an increased interest in the touching of the board while working problems or manipulating software at the board, as they exhibited control over what was occurring. No longer was an attached mouse the source of input—the student felt that he was the source of the input.

Students in the experimental group longed for the return of the board in their mathematics classroom and did notice its absence from its typical daily use. Even with other technology being utilized (the computer and lcd projector), students’ desire to use the interactive electronic whiteboard as part of the total collaborative presentation package was grand. These students saw the interactive electronic whiteboard as an integral part of the technology used in their classroom and desired for its continued use. Students’ consciousness of technology in their classroom was evident as they were able to reflect upon its use. Students reported that because technology (the interactive electronic whiteboard) was used, they were more interested in technology in general. They also reported that their interest in the class was a mix of interest in the technology used in the learning of new material and the new material itself.

The sentiments of students who had use of the board revealed a greater interest and self-described understanding of the mathematics taught during the research study because of the use of the interactive electronic whiteboard. They had more noticeable moments of mathematics understanding as a result of the interactive electronic whiteboard’s use and desired for the technology that promoted this understanding to be used more often and in a more interactive manner as students made used of the board in a one-on-one fashion to a greater extent.

Research Question Four

What is the nature of the interactive electronic whiteboard’s role in having an impact on students’ attitudes towards the teaching and learning of mathematics, as determined by clinical interviews?
The teacher-researcher and critical-friend’s observations, as well as clinical interviews with students in the control and experimental classes were used as a measure to determine the impact of the interactive electronic whiteboard on the students’ attitudes towards the teaching and learning of mathematics. The researcher observed, and students reported a greater interest in the mathematics and greater motivation to learn mathematics as a result of the interactive electronic whiteboard’s use.

Throughout the research study the control class had many observable moments of insights and understandings that were communicated (“Ahh-haa” moments) while the board was being used to teach a particular concept. These moments occurred much less frequently with students in the experimental class. The students who took part in these “Ahh-haa” moments expressed a greater appreciation towards mathematics as they described the interactive electronic whiteboard’s impact upon their mathematics learning. The attention of the students was also captured and expounded upon because of the prominent nature of the interactive electronic whiteboard and its use by the researcher while teaching. Students were more focused, more apt to have an “Ahh-haa” moment of understanding, and participated more in the class as the board served as a focal point throughout each lesson. The attention of the students in the experimental class was more difficult to gain and maintain by the researcher, who struggled with a different pace in presented lessons without the use of the board. Students’ attention was shifted and not held on to, and thus, less mathematical understanding, and appreciation, resulted.

Students were involved in more critical thinking activities and self-discovered problem solving as a result of the interactive whiteboard’s use. The board enabled the teacher to capture the attention of the students and then in turn facilitate their levels of reasoning and critical thinking, from a base level of understanding that had developed as students gained interest in the mathematics presented with the board. Students had more positive attitudes towards mathematics and were willing to take more risks in their own thinking and conjectures. Experimental group students were content with the base level knowledge of transformations and expressed no special interest in the presented content. The interactive electronic whiteboard’s impact upon student interest in the mathematics class brought about greater confidence in the student to think critically and make conjectures, allowing the student to think more positively about the process of learning
math. As the students thought they understood more, they reported that they began to “like math” more—including the challenge of figuring out the mathematics and deepening their understanding of the content material as the process was greater enjoyed.

Student motivation (the students’ ability to stay on task, listen attentively, take an active role in participating in class, contribute to the lesson, and having a willingness to learn) increased as a result of the interactive electronic whiteboard’s inclusion in the control class, and its comparative reflection of prior use in the experimental class. The focal point nature of the board enabled students to be more attentive. These more attentive students felt less bored, more involved with the teaching and learning of mathematics, and had more favorable outlooks upon mathematics. Students who did not have use of the board were more distracted, less attentive, and cared less about mathematics. The interactive electronic whiteboard’s positive impact upon student motivation led to students’ positive attitudes towards the process of mathematics.

Conclusions and Implications

Mathematics Content

The interactive electronic whiteboard itself did not prove to be an indicating factor of student achievement in a mathematics content area. All students in both the experimental and control classes saw a gain in learning or had no change between their pre and post test transformations unit scores. Both Bell, 2000, and Tate, 2002, related similar findings, that significantly small, or only a teacher-perceived learning gain occurred among students who had access to the interactive electronic whiteboard’s use as compared to students who did not have access to its use. Students were taught the same material by the same teacher-researcher, enhancing the validity of this research study. As many factors exist in the overall student learning gains in both classes, the strongest factor points to the good teaching and communication between teacher and student that occurred in both classes.

Student Visualization

Students’ scores on Wheatley’s Spatial Ability Test increased for all but two students in the research study (among both the control and experimental classes). There
was no statistically significant difference found in the students’ mean visualization gains as compared between the two classes. The students’ familiarity with transformations, specifically rotations (the key point in Wheatley’s test) likely arose from the week long unit on transformations that they had been exposed to. Covering a visually infused mathematics unit taught the student more visualization skills, as evidenced by the overall increase for all students. Ausburn and Ausburn’s 1978 statement that “today’s child is a visual child” holds true in 2004. Students exposure to visual means of communication, in movies, video games, on television, etc. likely accounted for their increased interest into the interactive electronic whiteboard’s use. As the students’ attention was captured by a means that they were familiar with and had become accustomed to, the whiteboard’s use, and transformations unit visual content, promoted greater visualization gains.

**Student Attitudes towards Technology**

Students in control and experimental classes echoed Tate’s (2002) sentiment of a found “perceived usefulness” of the interactive electronic whiteboard’s use in their classroom. Students stated that they enjoyed the use of the board and enjoyed learning more about the technology. Students were also more interested in the technology being used (a computer, lcd projector, and interactive electronic whiteboard) in the control class where the board was being used, as compared to the experimental class where the board was not being used. Students were less attentive and awe-stricken when only the computer and lcd projector were used. The collaborative and interactive means of presentation and learning with the electronic whiteboard provide a positive boost in students’ attitudes towards the use of technology. With the board’s use, students were more aware of technology in the classroom, attributed to the nature and prominent use of the board. Students stated that as technology was demonstrated they desired to use technology more, as students in the experimental class thought it was unfair, and did notice, that the board was not being used.

**Student Interest and Motivation**

The “dynamic learning atmosphere” (Fernandez and Luftglass, 2003) created by the interactive electronic whiteboard’s use led many (Bell, 2000, FERL, 2003, Knight,
2003, Tate, 2002) to conclude that the greatest impact of the board’s use in a classroom is upon student interest and motivation. Similar findings appear in this research study. Students exhibited increased levels of motivation and enjoyed the interaction that the board offers. Students were more attentive, contributed more, offered to volunteer more, and all round enjoyed to a greater extent the mathematics classroom that made use of the interactive electronic whiteboard. The teacher’s ability to use the board as a focal point and tool of transition led to the student’s perceived usefulness of the board, causing greater positive attitudes towards the learning and teaching of mathematics. Control groups students reflected upon the board’s use during this study while experimental group students reflected upon the board’s use in a prior classroom. Both sets of students concluded that they were more interested, felt they learned more, and appreciated to a greater degree a mathematics classroom where the collaborative, interactive nature of the electronic whiteboard was exploited.

**Impact upon Teacher**

Knight’s (2003) suggestion that the novelty of the board’s use, and its wearing off, must be accounted for as students report greater interest and motivation, is reinforced by this research study. The classroom teacher’s ability to integrate the board into his or her classroom must be met with a high level of expectation and continued use by the teacher and student. The use of the interactive electronic whiteboard, and it’s lasting effects, must balance the cost and training that comes with the board. Should the novelty of the board counteract student motivation and interest in the future, the negative impact of the board must be accounted for. All signs, as evidenced by this research study, point to a continued, or maintained, increase in student motivation, interest, and positive attitudes towards mathematics as a result of the board’s use. The teachers ability to integrate the interactive electronic whiteboard into his or her classroom on a routine basis will be a deciding factor among these stated student perceptions as well as the students’ attitudes towards the general use of technology. The teacher must facilitate the technology infusion in such a manner that students benefit in achievement and the classroom environment aspects of learning.
Recommendations for Further Study

The interactive electronic whiteboard’s integration into K-12 classrooms is an ongoing process and current issue. This study examined the impact of the board’s use and non-use in two seventh grade mathematics classes. The limitations upon sample size may cause some lack of generalizability, but the qualitative nature of examining the nature of the board’s impact on student attitudes towards technology and the teaching and learning of mathematics show a high level of transferability and extension among other mathematics classes, subject areas, and grade levels. With research studies such as Bell’s (2000), Tate’s (2003), and this one, the board’s initial introduction and impact on student learning and attitudes in a classroom become more generalized. However, the board’s lasting effects upon students, and teachers, should be studied. The following research questions are suggested in order to further build a wealth of useful information regarding the use of the interactive electronic whiteboard:

1. What is the nature of the impact of the interactive electronic whiteboard upon students’ perceptions and attitudes towards technology among different ages and grade levels?

2. What is the nature of the impact of the interactive electronic whiteboard upon students’ attitudes toward mathematics at varying levels?

3. How does the use of the board in more than one class affect students’ attitudes towards learning? Towards technology? Towards the instruction they receive?

4. What are the lasting effects of the board’s use upon mathematics students? Do these students retain more conceptual knowledge for longer periods of time?

5. What is the nature and impact of the interactive electronic whiteboard’s use with students of exceptionality? Students of disability?

6. Can curriculum and instruction material be developed that fully exploits the use of the board in the mathematics classroom that produces measurable learning gains?

7. What is the impact of the board’s use upon teachers? Does the teacher teach in a different manner with the board? What do they feel are the problems and benefits of the board’s use in the classroom?
8. What other computer peripheral devices can be used in conjunction with the interactive electronic whiteboard? Do these other devices positively affect student achievement and/or attitudes towards learning mathematics?
APPENDIX A

Transformations Unit Test
1. Point A is at (0, 2). The point is moved left 4 units and up 6 units. Find the coordinates of point A'.

2. Write a rule for the following translation. Point B is at (3, 5). Point B' is at (1, 3).

In 3 and 4, does each figure have line symmetry? If it does, draw the line or lines of symmetry.

3. 

4. 

In 5 and 6, draw a reflection of each figure across the y-axis.

5. 

6. 

In 7 and 8, use the figures.

7. Does Figure A have rotational symmetry? If it does, name all clockwise fractional turns that rotate the figure onto itself.

8. Figure A was turned \( \frac{1}{2} \) turn or less to get Figure B. How far was Figure A rotated to get Figure B?

9. Draw rotations of \( \triangle RST \) after clockwise rotations around the origin:

   a. \( \frac{1}{4} \) turn (Call this \( R'S'T' \).)

   b. \( \frac{1}{2} \) turn (Call this \( R''S''T'' \).)

10. Test Prep Which polygon is a translation of the figure at the right?
APPENDIX B

Wheatley Spatial Ability Test (WSAT)
The Wheatley Spatial Ability Test (WSAT)

This test measures student's ability to mentally rotate images of geometric figures. This dimension of spatial ability has been shown to be highly related to students' mathematical understanding and potential for mathematical thinking. Some students may not do well with arithmetical computations but still have some mathematical potential. The WSAT can identify these students.

Administration

It is important for students to answer directly on the test paper. Transferring answers to some optical scanning sheet interferes with the assessment.

This is a limited test. Be sure you have an accurate timing device. The time allowed for students to answer the 100 questions is eight (8) minutes. In order to compare scores with normed data, please adhere strictly to the time limit. Begin timing when you have completed the discussion of the first page and instruct the students to turn the page and start the test.

Time 8 minutes

Scoring

1. Determine the number of problems answered correctly, C.
2. Determine the number of problems answered incorrectly W. (ignore those not answered).
3. The student's score, S, is the number correct minus one-half the number incorrect.

Number correct (C)
Number incorrect (W)
Score = C - (1/2) x W

Example:

Sally, a fourth grade student, answered 83 of the problems leaving the last 17 blank. Of the 83 she answered, she missed 9. Thus the number correct (C) is 83 - 9 = 74 and the number incorrect is (W) is 9. Sally's score is figured below.

Score = C - (1/2) x W
Score = 74 - (1/2) x 9
= 74 - 4.5
= 69.5

Sally's score of the Wheatley Spatial Ability Test is 69.5. This score can be interpreted by referring to the table of norms. A score of 69.5 ranks in the 65th percentile. That is, Sally scored better than 65% of the students in the norm group.
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Be sure you have a stop watch or a watch with a second hand.

Distribute the test booklets. “Do not open your booklets until told to do so.” After booklets are distributed have students fill out information on the cover sheet. Walk around the room to identify any students who have questions or seem uncertain. Answer questions as they arise.

When all students have completed filling in the information on the cover page, say “Now all eyes up here.” Attach the figure labeled Figure 1 to the chalk board or any other convenient surface so that all the students can see it. Say: “Here is a figure I have put up on the board.” Hold up the shape labeled Figure 2 and say: “Here is another figure which is just like the first. Do you agree?” Place the second figure over the first so students can see they are the same. Now hold the second figure to the right of the first in a rotated position. “Can we get this shape by just turning?” (yes)

Now turn the second figure over and say: “I have turned over this figure. Can it be made to look like the first by turning?” (No) Rotate the second figure to show that no matter how it is turned it cannot be made to look like first. Be sure students understand this distinction before moving on. Repeat the demonstration if necessary.

Now have students look at the cover sheet of the test booklet. “See the row of five triangles? Put your finger on the triangle at the left.” Say “Each of the triangles in this row can be gotten by turning the first one.”

“Now put your finger on the two triangles below. These are not the same because they cannot be made alike by turning.”

Now read aloud the directions in the next paragraph while students follow along. Then have students work the examples by circling Y or N. Walk around the classroom and be sure students are circling a Yes or a No for each of the five items. Work individually with any students who are having difficulty. After students have finished, go over the correct solutions which are given in the paragraph following the examples.

Say “Now we are ready to begin. When I say go, open your booklet and start to work. Answer as many items as you can but remember, you are not expected to finish all items. (read more slowly) Work as quickly as you can but not so fast as to make careless errors.”

Get your time piece ready. Start timing when you say GO. Say “Go.” After EXACTLY eight minutes say “STOP.” Close your booklets.” Collect papers.
Cut out each figure for use in giving directions.

Figure 1

Figure 2
WHEATLEY SPATIAL ABILITY TEST

Form B

This is a test of your ability to see differences in figures. Look at the five shapes below.

All of these shapes are alike, but turned in different positions. Now look at the two triangles below.

These two triangles are NOT alike. The first cannot be made to look like the second by turning. It would have to be flipped over.

This test consists of sets of drawings, one drawing on the left of a vertical line and five problem drawings on the right. For each problem, you are to decide if the problem figure is like the figure on the left of the vertical line. If yes, circle the Y for that problem; if no circle N for that problem. Try the examples:

Examples 1, 3, and 4 are the same as the figure on the left of the vertical line, just turned in different positions. Examples 2 and 5 have to be flipped over to match the drawing on the left, so they are not the same as the left figure. So the answers you should have marked are Y, N, Y, Y, N. Work as quickly as you can, but not so fast that you make careless errors.

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TURN THE PAGE AND CONTINUE
APPENDIX C

Human Subjects Approval Letter
OFFICE OF THE VICE PRESIDENT FOR RESEARCH
HUMAN SUBJECTS COMMITTEE
TALLAHASSEE, FL 32306-2783
(850) 644-3323 • FAX (850) 644-4392

APPROVAL MEMORANDUM

Date: 4/20/2004

To: Matthew Robinson
375 John Knox Road Apt K101
Tallahassee FL 32303

Dept: MIDDLE AND SECONDARY EDUCATION
From: John Tomkowiak, Chair

Re: Use of Human Subjects in Research
The impact of the Interactive Whiteboard on Student Achievement in Middle School Mathematics

The forms that you submitted to this office in regard to the use of human subjects in the proposal referenced above have been reviewed by the Human Subjects Committee at its meeting on 4/14/2004. Your project was approved by the Committee.

The Human Subjects Committee has not evaluated your proposal for scientific merit, except to weigh the risk to the human participants and the aspects of the proposal related to potential risk and benefit. This approval does not replace any departmental or other approval which may be required.

If the project has not been completed by 4/13/2005 you must request renewed approval for continuation of the project.

You are advised that any change in protocol in this project must be approved by resubmission of the project to the Committee for approval. Also, the Principal Investigator must promptly report, in writing, any unexpected problems causing risks to research subjects or others.

By copy of this memorandum, the chairman of your department and/or your major professor is reminded that he/she is responsible for being informed concerning research projects involving human subjects in the department, and should review protocols of such investigations as often as needed to insure that the project is being conducted in compliance with our institution and with DHHS regulations.

This Institution has an Assurance on file with the Office for Protection from Research Risks. The Assurance Number is IRB00000446.

cc: Elizabth Jakubowski
HSC No. 2004.221
APPENDIX D

Informed Consent Letters
Dear Parent(s)/Guardian:

Attached you will find information regarding a research project that your child’s mathematics teacher, Mr. Matthew Robinson, will be conducting in your child’s classroom. This study is examining middle school students’ learning of mathematics and ways to improve instruction. Mr. Robinson is a graduate student in Mathematics Education at the Florida State University under the direction of Dr. Elizabeth Jakubowski. All students in your child’s mathematics class at FSUS are being asked to participate in this study. This project has been approved by both the Florida State University Institutional Review Board and by the Administration of this school. Please take the time to carefully read the attached document(s), sign the parental permission form, and return it to Ms. Eileen McDaniel, Research Director (Administration Building), or directly to Mr. Robinson by Friday, April 30, 2004.

If you do not wish for your child to participate in the project, we ask that you indicate so on the bottom of the consent form and return the form to the school. In this way we will know you have received and reviewed the project’s summary.

As a reminder, upon accepting an invitation for your child to attend the Florida State University School, you formally agreed to support the FSUS philosophy and mission of the school that emphasizes research on teaching and learning. We strongly encourage you to permit your child to participate in this study. Your child will not miss any academic class work or lessons while participating in this project. If you have any questions concerning this research project and your child’s involvement in the project, please do not hesitate to contact the researcher, Matthew Robinson (850-245-3796), or Eileen McDaniel, Research Director (850-245-3708).

Again, thank you for your continued interest and support of the educational programs and activities at the Florida State University School. We appreciate your active involvement in all aspects of your child’s education.

Sincerely,

Eileen L. McDaniel
Research Director

REMINDER!

Please return the enclosed Parent Permission Form to the school no later than Friday, April 30th.

If you have any questions or concerns about the research project, please call the researcher, Matthew Robinson (850-245-3796), or Ms. McDaniel (850-245-3708). Thank you for your assistance in furthering our mission as a research and developmental school that serves the needs of public education throughout Florida.
Human Subjects Committee
Parental Consent letter for Minors

Dear Parent,

I am a graduate student in Mathematics Education at Florida State University and Mathematics Teacher at Florida State University School. I am conducting a research study to examine middle school students' learning of mathematics and to explore ways to improve teaching.

Your child's participation will involve participating in a typical mathematics instructional program, lasting 50 minutes per day for six days, comprised of instruction in mathematics. Your child’s participation in this study is voluntary. If you or your child choose not to participate or to withdraw from the study at any time, there will be no penalty, (it will not affect your child’s grade). The results of the research study may be published, but your child’s name will not be used.

The possible benefit of your child’s participation is an enriched understanding of mathematics.

If you have any questions concerning this research study or your child’s participation in the study, please call me at (850) 245-3796.

Sincerely,

Matthew Robinson

I give consent for my child ____________________ to participate in the above study.

*Some students may be chosen for interviewing as part of a case study pertaining to the above research study. The short interview will be recorded for transcription purposes only. The recorded tapes will be kept by the researcher and locked in a filing cabinet. Only the researcher will have access to these tapes and they will be destroyed by December 31, 2004.

I give consent for my child ____________________ to be audio taped in the above study.

Parent’s Name: ______________________________

Parent’s Signature: ___________________________ Date: ______________________________
Human Subjects Committee

Child Assent Form

You have explained your project about using the interactive whiteboard in my mathematics class. I know that I can stop at any time I want. It will be okay if I want to stop; there will be no penalty, and my grade will not be affected. If I choose not to participate, my teacher will help me with an alternative activity.

I wish to participate. Name ________________________________
REFERENCES


Bell, M. A. (2000). *Impact of the electronic interactive whiteboard on student attitudes and achievement in eighth grade writing instruction*, Baylor University. (UMI No. 9963214)


McAllen (2002). Student Perceptions of the use and educational value of technology at the STCC Starr County Campus: implications for technology planning. *South Texas Community College, Office of Institutional Research and Effectiveness*.


Tate, L. (2002). Using the interactive whiteboard to increase student retention, attention, participation, interest, and success in a required general education college course. *Shepherd College*.


Matthew C. Robinson, a native of Tampa, Florida, attended the Hillsborough County Public School System from kindergarten through twelfth grade. A graduate of the International Baccalaureate Program at Hillsborough High School in 2000, Matthew went on to receive his Bachelor of Science in Secondary Mathematics Education at the Florida State University in 2003 and his Master of Science in Mathematics Education at the Florida State University in 2004.

Mr. Robinson is currently a high school mathematics teacher at Florida State University School in Tallahassee, Florida and is actively considering pursuing a Ph.D. at the Florida State University.