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TECHNOLOGY IN THE CLASSROOM: THE INTERACTIVE WHITEBOARD

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Adolescence Mathematics Education

by

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies for acceptance, a thesis entitled "Technology in the Classroom: The Interactive Whiteboard" submitted by Brittany L. Schenk in partial fulfillment of the requirements of the degree of Master of Science in Education.

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ABSTRACT

This project will focus on answering two questions about the use of an interactive whiteboard in the mathematics classroom.

1) What effect does the use of an interactive whiteboard in the mathematics classroom have on student achievement?
2) What training is provided by a school district so that teachers can learn to adequately use newly acquired technology?

The first question was answered by selecting two homogenous classes; one with an interactive whiteboard and one without. Both the experimental and control group were administered a pre-test at the beginning of a unit and a post-test at the end of that unit. A paired sample t-test was used to determine whether there was a significant difference between the means. The experimental and control group together were made up of forty-three Math B students that were similar in gender, age, ability and performance. The second question was answered by attending the training session on the interactive whiteboard provided to a school district in New York State and by analyzing survey data collected from two school districts on training received on the interactive whiteboard.

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INTRODUCTION

In 1991, SMART Technologies© introduced the first interactive whiteboard to the world. In those past fifteen years, the interactive whiteboard has been making its way into the education, business, and government worlds. However, it was teachers who first saw the significance of this amazing new technology and the implications it could have in a classroom. There are numerous ways the interactive whiteboard could be used in a school setting, such as, instructional purposes, student collaboration, and professional development. The interactive whiteboard has the ability to transform a school district as well as a classroom.

The interactive whiteboard combines the power of a computer with the simplicity of a whiteboard. With a touch-sensitive display it connects to your computer and digital projector to show the images on your computer. A teacher can then control computer applications directly from the display. The interactive whiteboard also allows a teacher to write notes in digital ink and save work to share later.

There are three main kinds of interactive whiteboards that can easily be incorporated into a classroom setting. One type is front projection, which works with an already existing computer and projector. Images from the computer are displayed on the front of the interactive whiteboard. A second type is rear projection, which includes an integrated projector. Images from the computer are displayed through the back of the interactive whiteboard. This type of interactive whiteboard can be a mobile unit or permanent installation. The last type is the flat panel display. This type of interactive whiteboard fits over an existing plasma display or LCD screen.

Research on the use of the interactive whiteboard and its impact on the classroom, students, and teachers have been conducted in a variety of areas in education. Some of these areas include music, science, special education, language arts, history and mathematics. Within these areas, research has been conducted, with regards to the interactive whiteboard on effectiveness of the use of the interactive whiteboard (Damcott, Damcott, Landato, Marsh. 2000), student retention (Tate, 2002), teacher perception (Bell, 1998), test performance (Elvers, 2000), integration (Jamerson, 2002), and student motivation (Weimer, 2001), just to name a few.

For many years, technology was not viewed as a major component in education. It was taught as a separate subject and not integrated in the classroom. The successful integration of technology into classrooms has been a goal for generations of instructional technology researchers and practitioners (Cuban cited in Winn, 1989). With the introduction of the interactive whiteboard, it is now possible to combine technology and curriculum as a seamless assimilation into the classroom. In 2000, the National Council of Teachers of Mathematics (NCTM) published the *Principles and Standards for School Mathematics.*

One of the six principles is the Technology Principle, which states that technology is essential in teaching and learning mathematics; it influences the mathematics that is taught and enhances students' learning (NCTM, 2000). Recent studies in mathematics education indicate that the interactive whiteboard is doing just that.

Purpose

The purpose of this project is to determine whether or not the interactive whiteboard has a positive impact on student achievement in grades 9-12 mathematics. In recent studies, researchers have suggested that the interactive whiteboard has great potential to facilitate the teaching of very different concepts which have a strong dynamic visual component (Davison, 2004). Others have praised it for incorporating multiple representations (Steckroth, 2006), creating dynamic learning environments for students (Fernandez, Luftglass, 2003), and improvement in mathematical thinking skills (Merrett, Edwards, 2005). There are not many projects that have been conducted regarding the effects of the interactive whiteboard on student achievement. Through a variety of different studies, the interactive whiteboard has shown us that it is beneficial in other aspects of the classroom and education. It is the goal of this project to determine what effect this piece of technology has on student achievement in mathematics.

Another portion of this project will focus on the training that teachers receive for using the interactive whiteboard. With research indicating that the interactive whiteboard has the ability to transform education, it follows that districts should provide the support and training to their staff. Two school districts' training methods were observed for this project. One school district had received a single interactive whiteboard for the high school, and the other received interactive whiteboards for every classroom. After the training session from their respected school district, all teachers in the mathematics department were surveyed about their feelings towards the interactive whiteboard and the training they had received.

Before reporting the findings of this study, background on what the research indicates about the interactive whiteboard will be provided. It will address possibilities of the different pedagogic skills needed for the use of the interactive whiteboard and provide suggestions for the training and professional development of the interactive whiteboard.

Review of Literature

Current Research

Over the past fifteen years, research has been conducted on the interactive whiteboard. It has covered many disciplines of education as well as many important topics that occur in education. Within the United States, school districts are slowly beginning to acquire interactive whiteboards.

European Schoolnet (2006) recently conducted research on the impact of information and communication technology (ICT) on student achievement. The results showed that the interactive whiteboard improved test scores, especially in subjects such as mathematics and science. The study was conducted from 2002 to 2006. The results were drawn from a total of 17 studies conduct in the UK and other parts of Europe during this time period. The study also concluded that digital content on interactive whiteboards is engaging and motivating, and students pay more attention during lessons; and interactive whiteboard use encourages greater student participation in the classroom. (SMART Technologies Inc., 2007)

One of the longest-running interactive whiteboard educational research programs in existence is SMARTer Kids™ Research (http://www.smarterkids.org/research). It is sponsored by the SMARTer Kids Foundation of Canada and offers a broad range of research conducted on the interactive whiteboard. One case study in particular was recently conducted in Gloucester City, New Jersey with its main goal to improve student performance, especially in mathematics. Being a low socio-economic school district, they were able to get thirty five interactive whiteboards through state funding. The study indicated that overall student performance increased, with mathematics scores increasing by sixteen percentage points with the implementation of this new technology (SMART Technologies, 2005). Other school districts in the United States are conducting case studies on the use of the interactive whiteboard and the effects it has on classroom teaching. There are a small percentage of these studies focusing on the mathematics classroom.

Within recent years, a great deal of research has been conducted in the United Kingdom, especially England. The Interactive Whiteboard Research Group together with Keele University has conducted over twenty-five studies in the past seven years. All of these studies pertain to the use of the interactive whiteboard in mathematics. Some of the topics that The Interactive Whiteboard Research Group covered in their studies are, but not limited to, professional development of mathematics teachers (Miller, Glover, 2006), developing pedagogic skills (Miller, Glover, Averis 2005a), the effective use of the interactive whiteboard in the mathematics classroom (Miller, Glover, Averis 2005b) and enhancing mathematics teaching (Miller, Glover, Averis, 2004). The research conducted by Keele University on the interactive whiteboard and the mathematics suggests that it has a positive effect in all aspects of the classroom.

Pedagogy and Presentation

Incorporating the interactive whiteboard into the classroom can have an impact on the way lessons are prepared and delivered. This being said teachers who use this technology in their classrooms need to break from traditional teaching methods and focus on developing deeper pedagogical skills regarding the interactive whiteboard. Miller, Glover, and Averis (2005a) suggest that the interactive whiteboard has both the ability and the resources to support visual, verbal, and kinesthetic learning styles.

In a recent study conducted in England (Glover et al, 2005), different pedagogic phases were reached by teachers as their fluency with the interactive whiteboard grew stronger. The three levels that were achieved included: supported didactic, interactive, and enhanced interactive.

Supported didactic was the most basic of the phases. This approach is primarily used by those teachers who focus on traditional approaches and use the interactive whiteboard mainly as a visual aid. Also, this phase is most often found in classrooms where the interactive whiteboard is just being introduced and the teacher is not familiar with all the options it has to offer. The study concluded that pedagogically in this stage, the interactive whiteboard, “illustrates, rather than develops concepts” (Miller et al, 2005a, p. 3).

The second stage, interactive, is a transition from the first stage. The interactive whiteboard is incorporated into the lesson more by, “using a variety of verbal, visual, and aesthetic stimuli” (Miller et al, 2005a, p. 4). It is also used to illustrate, develop, and test discrete concepts. Teachers in this stage tend to be more comfortable with the given technology. They are able to use the interactive whiteboard as an integral strategy for conceptual development.

The final step in the pedagogic progression is enhanced interactive. In this stage, the interactive whiteboard becomes an integral part of the classroom. The teacher can exploit the interactive capacity of the technology by integrating concept and cognitive development into lessons. In this stage, techniques used by teachers are beginning to be mastered. Here, the interactive whiteboard is used as a means to prompt discussion, explore processes and develop hypotheses or structures. Through increases in active learning, teachers begin to show enhanced understanding of the learning process.

Teachers, who exhibit enhanced interactivity, structure the learning process and encourage learning which can be classified in three ways. The first is called intrinsic stimulation. This is the combination of visual, kinesthetic and auditory paths to learning. This is followed by sustained focus, which is achieved by the teacher's management skills throughout the lesson. Finally, there is stepped learning, which is continuous challenges with frequent assessment. This is to stimulate further involvement by the student. These pedagogic steps were all included in a study by Miller, Glover and Averis (2005a) in which the effective use of the interactive whiteboard in the mathematics classroom was examined. The results showed that an increased understanding in mathematics occurred. However, in order to maximize learning, a teacher must be competent with the technology and pedagogy.

Many techniques that are featured on the interactive whiteboard can enhance the pedagogic skills one must develop when using this technology in the classroom. Miller et al (2005a, p. 6) lists the manipulations that are commonly used with the interactive whiteboard.

These manipulation techniques include:

- ***drag and drop:*** matching a response to a stimulant and used for classification, sequencing, grouping, matching, processing of data, the creation of questions arising from the dragging and the organization of material – observed in, for example, drag and drop a fraction onto its correct position on a number line; drag a line into place to help read data from a graph; drag four decimals into the correct numerical order; drag the equation of a line to the correct graph.

- ***hide and reveal***: opening a hidden response when the stimulant was understood, and also enabling material to be revealed as conceptual development takes place, stepping the development of hypotheses, and changing sequencing – observed in, for example, revealed answers after addition questions, revealing the answer to an addition of fractions after discussion of methods; revealing the position of a quadratic graph after pupils have plotted the points on a grid; and revealing the shape after pupils have been given information about it and have established its shape.
- ***color, shading and highlighting:*** used for the collection of like terms, enhanced explanation, analysis through annotation and reinforcement through greater emphasis – observed in, for example, handling complex fractions from the fraction wall; using color to help pupils to distinguish between different variables in an equation; using color to help pupils with work on multiplying a number with a bracket; and using color to distinguish between positive and negative numbers.
- ***matching:*** often using software to match items in some way – observed in, for example, matching equivalent fractions; matching a decimal with a fraction and a percentage; matching a statement with the probability associated with it.
- ***movement or animation:*** to demonstrate principles and to illustrate explanations – observed typically in stepped solutions that are animated by software, for example, an animation of how to make a tangram; an animation of how to add

decimals; an animation showing that angles on a straight line add up to 180 degrees.

- ***immediate feedback***: from teacher, pupil or software often arising from direct consequence of one of the other five methods.

The above manipulations are not the only ones that the interactive whiteboard has to offer. As teachers become more experienced with the interactive whiteboard, they may slowly start to pick up more manipulations and generic skills.

As noted before in the research (Glover et al, 2005), teachers will transition through three stages of pedagogic change when using the interactive whiteboard. Pedagogy is extremely important in a mathematics classroom and even more important when incorporating technology. A teacher may need to develop different pedagogic skills when working with the interactive whiteboard. Some teachers may be hesitant at first; however, with proper training and motivation, integrating the interactive whiteboard into the classroom can be seamless.

METHODS

In this section of the project the methods of this experiment is discussed. The type of participants, measures and materials used, intervention and data coding procedures are listed in full detail so one may reproduce this experiment.

Participants

Thirty-five Math B students ranging from tenth to eleventh grade from a public school in the Mid-Hudson Region of New York participated in this study. Students who were receiving special education services were not excluded from participation. Forty-three students were eligible to take part in the study; however, eight were excluded given that they did not complete either the pretest or posttest.

Measures

The thirty-five participants in this study were broken into two predetermined groups: experimental and control. The experimental group consisted of twenty students. They received instruction daily with the interactive whiteboard throughout the unit. The control group consisted of fifteen students. This group did not receive any instruction with the interactive whiteboard throughout the unit. The instructor volunteered to participate in this study because of his interest in the interactive whiteboard. The instructor chose two sections of Math B that were similar in age, gender, ability, and performance.

Materials

Materials used in this study were a pretest and a posttest. The pretest consisted of questions taken from previous Math A Regent's exams. The posttest consisted of questions taken from previous Math A and Math B Regent's exams. The pretest contained nine questions and the posttest contained twelve questions. For the pretest, the material was factored in as prior knowledge for the students since they were all in Math B and must have passed the Math A Regent's exam to continue the sequence in mathematics. For the posttest, questions from both the Math A and Math B Regent's exam were used since the students had just revisited and learned material pertaining to this topic. The problems used for the pretest and posttest are provided in Appendix A and Appendix B, respectively. The results of the pretest and the posttest are provided in Appendix C and Appendix D, respectively.

Intervention Procedures

The pretest was administered before the intervention of the interactive whiteboard in this unit. All students involved were allowed to use their TI-83, TI-83+, or TI-84 graphing calculators. They were all given adequate time to finish the pretest. Most of the students finished within fifteen minutes. Minimal assistance was given to students, when they had questions, to clarify a problem. The same guidelines were used for the posttest.

After the pretest, the interactive whiteboard was incorporated into the daily lessons of the experimental group. The control group received no interaction with the interactive whiteboard throughout the unit. The unit lasted for approximately one and a half weeks.

Data Coding Procedures

The pretest consisted of eight multiple choice questions and one full answer question. The full answer question was a four part question where the students were asked to graph a given equation. The remaining part of the problem consisted of answering questions pertaining to the equation the students graphed. The posttest consisted of 11 multiple choice questions and one full answer question. The full answer question was presented in the same format as the full answer question in the pretest. The answers to the pretest and the posttest are located in Appendix E. The two tests were scored independently by the instructor and the researcher, and the results of the scoring were compared. If the scores of the full answer questions were different, discussion of the problem was held between the instructor and researcher. This was done in order to see whether the differences in grading could be reconciled. After evaluating the scores on the full answer questions, it was revealed that there was 93% or more agreement on the problems. Since there was such a high percentage of agreement on the scoring of the problems, the scores of the researcher were used for the statistical analysis.

In this section of the project the process of the survey is discussed. The type of participants, materials used, and data coding procedures are listed in full detail so one may reproduce this type of survey.

Survey

The Southern Tier school district and the Hudson Valley school district both participated in this survey. The purpose of the survey was to find out the teachers feelings towards both the interactive whiteboard in the classroom and the training they received on the interactive whiteboard. The surveys remained anonymous and after each question the teacher was asked to comment.

Participants

Seven teachers from The Southern Tier school district took part in the survey on Interactive Whiteboard Training. Six teachers from the Hudson Valley school district took part in the survey as well. All teachers involved in the survey were high school teachers.

Materials

All teachers were given six multiple choice questions to answer on the training they have received and their attitude towards the interactive whiteboard. Each question had a space to provide comments on that particular question. The survey is provided in Appendix F.

Data Coding Procedure

Each school district's results were tallied separately. The tallies were then placed in percentage format. For example, when asked "I feel my school district should offer more professional development sessions related to the IWB and its uses within the classroom," two of the teachers from the Hudson Valley school district strongly agreed and four teachers agreed with this statement. That represents 33% and 67%, respectively. The results to the interactive whiteboard training survey are provided in Appendix G.

DATA ANALYSIS

Student Achievement and the Interactive Whiteboard

The data was analyzed using the computer statistics program SPSS. A series of tests were run to determine whether an ANCOVA test was appropriate. This test allows you to remove the effect of a known covariate. In order to run an ANCOVA test, there are some assumptions and limitations. The results of the ANCOVA tests will only be valid when the assumptions are not violated. To determine whether these assumptions are violated a Pearson correlation was calculated, along with a one-way ANOVA test. The descriptive statistics were also calculated to better interpret the data.

To begin the analysis of the data, the descriptive statistics of the experimental group and the control group were looked at individually. For the experimental group, the mean of the pretest was 46.8 and the mean for the posttest was 71. This left a difference between the means at 24.2. For the control group, the mean of the pretest was 40.6 and the mean for the posttest was 64.7. This left a difference between the means at 24.1. The descriptive statistics can be found in Appendix H.

The goal of this project was to determine whether there was a statistically significant difference between the means, showing that the interactive whiteboard increased students' achievement. The first test indicated that there was statistically no significant difference; however, more tests were run to determine the exact significance.

A one-way ANOVA (analysis of variance) was run to determine whether there were differences between the means. The one-way ANOVA compares the means of two or more groups of subjects that vary on a single independent variable. This test requires a single dependent variable and a single independent variable. A one-way ANOVA test was run on the pretest, posttest, and the difference between pretest and the posttest. The results were as follows:

a) The pretest means of students who participated in this study were compared using a one-way ANOVA. No significant difference was found ($F(1,33)=.509$, $p>.05$). The students from the two different classes did not differ significantly at the start of the unit.

b) The posttest means of students who participated in this study were compared using a one-way ANOVA. No significant difference was found ($F(1,33)=.508$, $p>.05$). The students from the two different classes did not differ significantly at the end of the unit.

c) The difference between the pretest means and posttest means of students who participated in this study were compared using a one-way ANOVA. No significant difference was found ($F(1,33)=.000$, $p>.05$). The difference between the means of students from the two different classes did not differ significantly.

The one-way ANOVA tables are provided in Appendix H.

A multiple linear regression test was then run on the data. The multiple linear regression tests assumed that all variables are interval or ratio scaled. The purpose of this test is to determine whether the data between the pretest and the posttest are related linearly. Within the multiple linear regression tests, the Pearson correlation coefficient was calculated. This coefficient determines the strength of the linear relationship between the two variables. The results are as follows:

A Pearson correlation was calculated examining the relationship between the pretest and the posttest scores. A weak correlation that was not significant was found ($r(33)=.242$, $p>.05$). The pretest scores are not related to the posttest scores.

From the output of the multiple linear regression tests, the *r* and R^2 values were given and interpretation on them was then possible. First, the R^2 value is the variation in the posttest that can be explained by the pretest and the groups. The value for R^2=.067 which means only 6.7% of the variation in the posttest can be explained by the pretest and the groups. A value of *r* =.260 was given for this test. A general rule of thumb, shown by Cochran (1957), is that the use of a covariate whose correlation with the dependent variable is less than .3 does not lead to an appreciable increase in the precision of the analysis. Since *r* =.260, which is less than 0.3, this statement is supported. Therefore, this gives no support to run an ANCOVA test because not all of the assumptions hold true. The result of the multiple linear regression tests is provided in Appendix H. Based on the data collected and calculated, it was determined that there was no statistically significant difference between the means of the control group and the experimental group.

Training with the Interactive Whiteboard

With the advancements made to technology, it is now easier for schools around the country to incorporate technology into the classroom. However, more times then not, it failed. Winn (1989) indicated that most often, teachers' resistance in using given technology was identified as one of the major reasons for the failure of technology to transform education. Perhaps this is because of the lack of training provided by school districts when acquiring new technology.

Two school districts in New York State, one in the Southern Tier and one in the Hudson Valley recently obtained interactive whiteboards for their school district. The school district located in the Southern Tier was given one interactive whiteboard for each of the three schools in the district. The school district located in Hudson Valley was given an interactive whiteboard for each classroom in the district. This school district also made available an overhead projector for each classroom, if they did not have one prior to the implementation of the interactive whiteboards.

Training for the interactive whiteboard in the Southern Tier school district was observed by the researcher. Focusing on the high school, each department was trained separately. Each teacher was given a handout from Smartboard©. This handout was the Smartboard© Users Guide that is given to buyers of this particular interactive whiteboard. Within the packet, Smartboard© walks the user through the steps to set up the interactive whiteboard and use specific tools. The instructor of this training session showed how to configure the board and how to use some common tools. The overall training session was approximately thirty minutes.

Training for the interactive whiteboard in the Hudson Valley school district was more thorough than that of the previously mentioned school district. Similarly, each faculty member was given a Smartboard© Users Guide and each department was again trained separately. For the first training session, each department was given a brief description of an interactive whiteboard, an explanation of how to configure the board, and how to use some common tools. Following this training session was a professional development workshop dedicated solely to the training of the interactive whiteboard. This workshop took place over two days. Each department trained separately, therefore allowing for specific details of the interactive whiteboard to be discussed pertaining to a certain discipline.

The mathematics department went in depth on common manipulations, tools used for drawing, and programs that could be used with the interactive whiteboard. One of the most common programs used with the interactive whiteboard in mathematics is TI-Smartview©. This program incorporates the use of the TI-84+ graphing calculator. It has the power to display algebraic, tabular, and graphical representations simultaneously (Steckroth, 2006). For the final part of the training, the teachers were allowed to play around with the interactive whiteboard and ask questions.

After comparing the two school districts, it was obvious that there could have been more training for the teachers in the Southern Tier school district. A thirty minute training session was not sufficient when incorporating new technology into the classroom. The teachers were asked on the Interactive Whiteboard Training Survey, located in Appendix A, “After the training session that was offered by my school (Southern Tier), I feel that I was adequately prepared to use an IWB in my classroom?” The response was negative, 57% of the teachers disagreed and 29% of the teachers strongly disagreed that they were adequately prepared. Perhaps this is why teachers get frustrated and do not typically use the technology that is given to them. The Hudson Valley school district did a sufficient job in training their staff to implement the interactive whiteboard in the classroom. When asked the same question on the survey, 66% of the teachers agreed and 17% of the teachers strongly agreed that they were adequately prepared.

Based on observations of training provided by the school districts and the results of the Training Survey, recommendations on how teachers should be trained when using the interactive whiteboard may be made. These recommendations are provided in the next section.

Conclusion

Factors to consider

Before the implications from the results of this study are provided, some factors that should be taken into consideration when teaching mathematics will be noted. The data presented in this project provides a picture of students' performance from an academic standpoint only. In general, however, it is commonly recognized that there are many factors that contribute to a student being successful in mathematics. Some of these factors can include, but are not limited to: testing issues, learning disabilities, lack of motivation, emotional disorders and attendance. Some of the students in both the experimental and control groups struggled with these factors. For example, four students in the experimental group and six students in the control group were identified as having a learning disability. As a result, both classes had a special education teacher in it as well as the normal mathematics teacher. The special education teacher was there to assist those students with learning disorders. Any accommodations that those students normally received were provided during both the pretest and the posttest. Though the special educator provided additional assistance for those students with special needs, he or she did not propose plans to solve problems nor provide any solutions for the problem.

Implications

This project was conducted in a specific place, with students who had a unique set of needs, and taught using a certain style of teaching. The classes included in this project were below grade level and on-grade level students. Therefore, one must be careful to generalize the results to a situation that may be quite different. Each testing environment presents unique circumstances which must be considered when implementing a different way of teaching mathematics.

Recommendations for Further Research

The results of this study indicate that there was no statistically significant difference between the mean scores of students who were taught using the interactive whiteboard and those taught without an interactive whiteboard. That is, there was no difference in student achievement between the two groups studied. This outcome is surprising after research has showed that it improves a variety of other aspects of the mathematics classroom. This project contradicts case studies that showed that the interactive whiteboard increases student achievement. However, several factors come into play that may have contributed to the results of this project.

One factor may be because some students do not find mathematics enjoyable. They may lack motivation to try new things or just refuse to make an effort. Another factor lies in the hand of the instructor. An instructor must be enthusiastic about using technology in his or her classroom, particularly the interactive whiteboard. If instructors do not believe that the interactive whiteboard will make a difference in their classroom, then they may not use it to its full potential. The interactive whiteboard is more than a projection screen. It allows teachers to use manipulative, interactive web sites, mathematics programs, and specific tools.

Two major factors that may have contributed to the results of this project are the duration of the intervention and the training received by the instructor. The duration of the project lasted between seven to ten school days. Though the interactive whiteboard was located in the classroom prior to the intervention, it was the first time the students saw it in action during class time. The length of the intervention did not give the student enough time to get over the novelty factor of the interactive whiteboard. Students are oftentimes excited when new elements arrive into their surroundings and tend to focus less on the task at hand. Additional research on this topic may help support this idea. Second is the training the teacher received. Training sessions that were provided by the school district were not ideal for conducting this study. The instructor could have been uneasy using the interactive whiteboard, not familiar with its tool and applications, or lacking experience overall.

Recommendations for Training

Training is essential when incorporating any new technology into the classroom. It is important that teachers feel prepared to use the interactive whiteboard in their classroom. Throughout the duration of this project, the researcher attended training sessions at the above mentioned school districts. Based on observations, the researcher has developed recommendations for training of the interactive whiteboard.

The first recommendation is that before a school district purchases interactive whiteboards, they must be sure they can provide the proper training and professional development that should be given to teachers when incorporating new technology into their classroom. All teachers should receive the user's guide to their interactive whiteboard. An introductory session should be given to the entire staff introducing them to the interactive whiteboard. During this session, basic skills such as setting up the interactive whiteboard, turning on the equipment, and configuring the board should be demonstrated. These basic steps are important to know for anyone who is going to use the interactive whiteboard. A follow up training session should be conducted by departments. Training staff within their respective departments creates smaller groups, which are easier to train.

The above recommendations follow for any teacher who is incorporating the interactive whiteboard into their classroom. The following recommendations are geared towards the mathematics teacher. During this training session teachers should be shown common manipulations, tools used for drawings, and programs that can be used with the interactive whiteboard. Common programs used are the TI-Smartview© and Geometer's Sketchpad©. Teachers should also be shown common websites that have interactive whiteboard lessons and ideas. Many of the interactive whiteboard providers, such as Smartboard©, offer free training materials and many times is available on their web site. For instance, the Smartboard© web site offers free tutorials, live online training, training events across the country, and on-site training. Many other makers of the interactive whiteboard offer similar training programs. The last recommendation is that professional development sessions pertaining to the training of the interactive whiteboard are important. The researcher recommends that school districts who want to take full advantage of the benefits of the interactive whiteboard have a training session available to their staff at least once a year. For newly acquired interactive whiteboards, the researcher recommends that school districts offer two training sessions before the implementation of the interactive whiteboard into the mathematics classroom.

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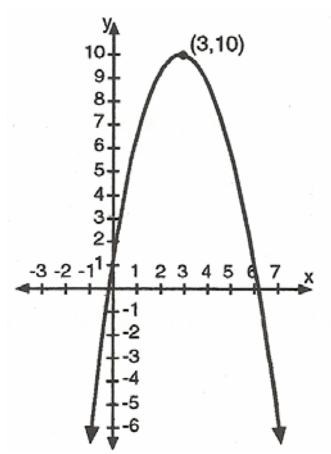
Appendix A
Parabola Pretest

1) The graph of the equation $y = ax2 + bx + c, a \neq 0$, forms

A) an ellipse
B) a circle
C) a parabola
D) a straight line

2) What equation defines the graph in the diagram below?

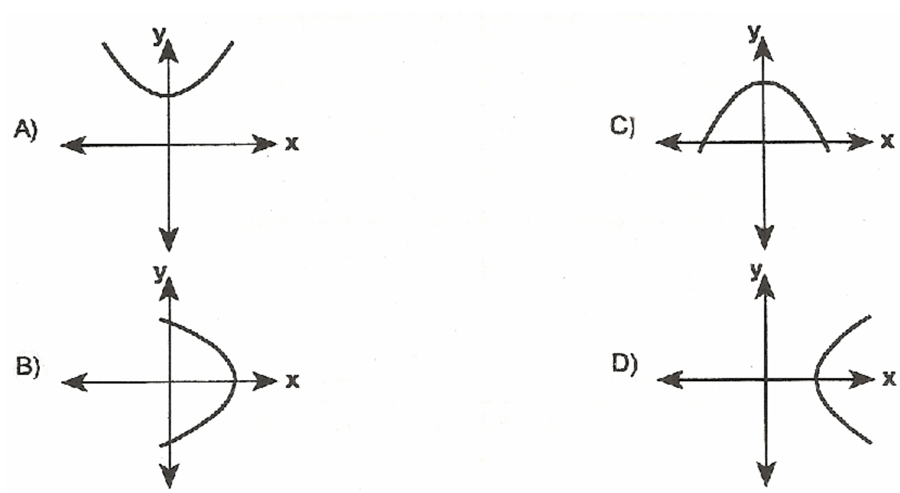


A) $y = x2 + 3x$
B) $y = x2 + 6x + 1$
C) $y = -x2 + 6x + 1$
D) $y = -x2 + 3x - 1$

3) What is the y-intercept of the graph of the equation $y = x2 – 2x + 3$?

A) 2
B) 1
C) -2
D) 3

4) Which one of the following graphs could represent the equation $y = -x2 + 4$?



5) What is the equation of the parabola that intersects the x-axis at the points (2,0) and (5,0)?

A) $y = x2 + 10x + 7$
B) $y = x2 – 7x + 10$
C) $y = x2 – 10x + 7$
D) $y = x2 + 7x + 10$

6) The coordinates of the turning point of the graph of the equation $y = x2 – 2x - 8$ are $(1, k)$. What is the value of k?

A) 8
B) -9
C) 3
D) -12

7) For the graph of which one of the following equations is $x = 2$ an equation of the axis of symmetry?

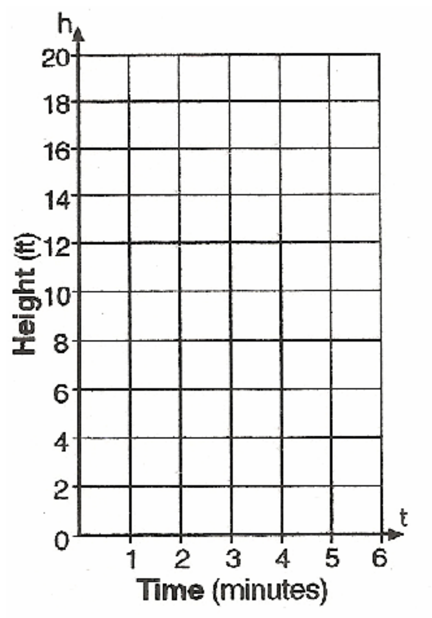
A) $4x2 – 2x + 10 = y$
B) $3x2 + 6x – 8 = y$
C) $x2 - 4x - 6 = y$
D) $x2 + 2x – 3 = y$

8) What is the equation of the axis of symmetry of the graph of the equation $y = 2x2 – 3x – 1$?

A) $y = \frac{3}{4}$
B) $x = \frac{3}{4}$
C) $x = \frac{3}{2}$
D) $y = -\frac{3}{2}$

9) Susan tossed a ball in the air in such a way that the path of the ball was modeled by the equation $h = -2t2 + 12t$. In the equation, *h* represents the height of the ball in feet and *t* is the time in seconds.

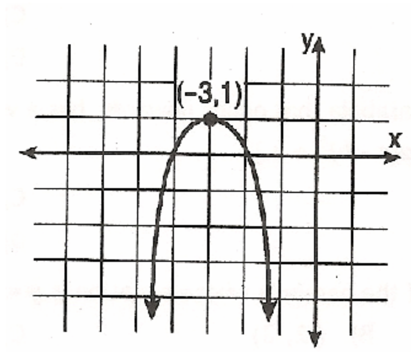
a) Graph $h = -2t2 + 12t$ for $0 \leq t \leq 6$.
b) At what time (t) is the ball at its *highest* point?
c) What is the maximum height of the ball?
d) What is the height of the ball at time $t = 5$?



Appendix B

Parabola Posttest

1) Which equation represents the parabola shown in the graph below?



A) $f(x) = -(x + 3)2 + 1$

B) $f(x) = -(x - 3)2 - 3$

C) $f(x) = (x+1)2 - 3$

D) $f(x) = -(x-3)2 + 1$

2) A model rocket is launched from ground level. Its height, *h* meters above ground, is a function of time *t* seconds after launch and is given by the equation $h = -4.9t2 + 68.6t$. What would be the maximum height, to the nearest meter, attained by the model?

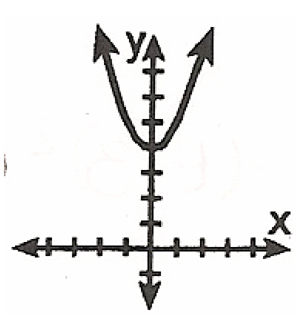
A) 240 B) 243 C) 242 D) 241

3) Which is an equation of the axis of symmetry of the graph $y = 2x2 - 6x - 14$?

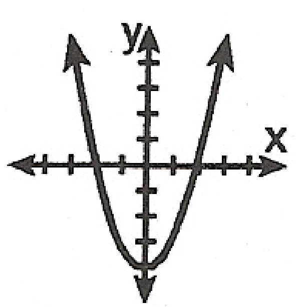
A) $x = -6$ B) $x = \frac{3}{2}$ C) $x = 6$ D) $x = -3$

4) Which of the following could be the graph of $y = (x+4)2$?

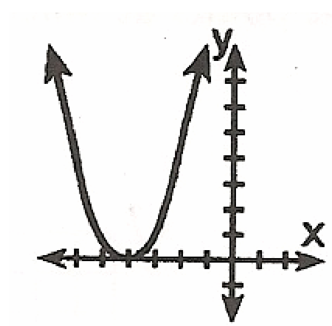
A)



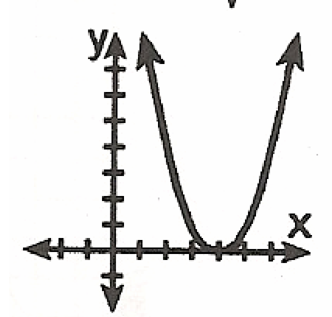
B)



C)



D)



5) What is the y-intercept of the parabola whose equation is y = x2 +7x + 5?

A) 3 B) $\frac{7}{2}$ C) $-\frac{7}{2}$ D) 5

6) The graph of the equation y = ax2 +bx + c, $a \neq 0$, forms

A) an ellipse
B) a parabola
C) a straight line
D) a circle

7) Which is true of the graph of the parabola whose equation is $y=x^2-2x-8$?

A) The only x-intercept is at x=4.
B) There are no x-intercepts.
C) The x-intercepts are at x=2 and x=-4.
D) The x-intercepts are at x=4 and x=-2.

8) For the graph of which equation is x=2 an equation of the axis of symmetry?

A) $3x^2 +6x - 8 = y$
B) $x^2-4x-6 = y$
C) $x^2+2x-3 = y$
D) $4x^2 - 2x +10 = y$

9) Write the equation of the parabola that opens upwards, has a vertex V(2,-3), and is congruent to $y=x^2$. [Place the answer in the form $y = a(x-h)^2 +k$.]

A) $y = (x+2)^2 - 3$
B) $y = (x-2)^2 +3$
C) $y = (x+2)^2 +3$
D) $y = (x-2)^2 -3$

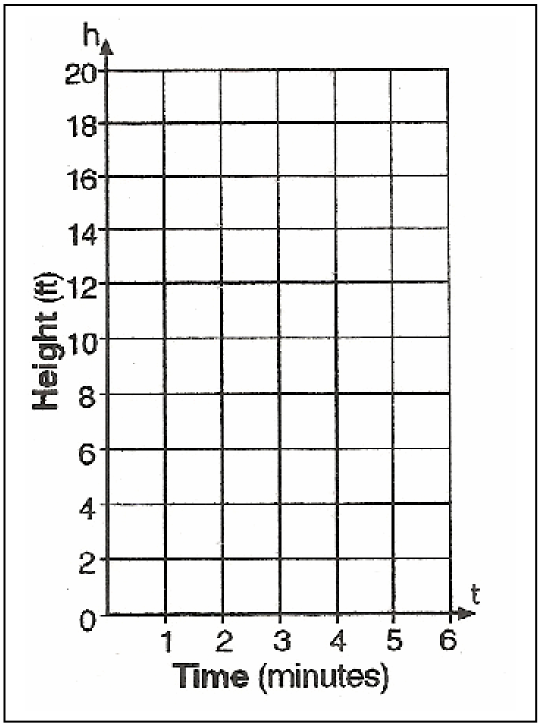
10) What is the turning point of the parabola whose equation is $y = 2x^2 + 4x -3$?

A) (-1,-5) B) (-2,-3) C) (1,3) D) (2,13)

11) The height of a drop of water in a fountain is given by the formula $h = -t^2 +4t +5$ where *h* is the height in meters and *t* is the time is seconds after being released. Find the height of a drop of water 2.6 seconds after it is released. [Round the answer to the nearest tenth.]

12) The path of a small bottle rocket launched from the ground can be represented by the equation
$h = -(t - 3)^2 + 9$ where t = time in the seconds and h = height in meters.

a) Graph and label the path of the bottle rocket using the time interval $0 \le t \le 6$.
b) What is the maximum height the rocket reaches?
c) How long does it take for the rocket to reach its maximum?
d) Circle and label the points at which the rocket is on the ground.



Appendix C
Pretest Results

Experimental Group

Questions k =12

Students n = 20

Students	1	2	3	4	5	6	7	8	9a	9b	9c	9d
1	1	1	1	1	1	0	1	0	0	0	0	0
3	0	0	0	0	1	0	0	0	0	0	0	0
4	1	0	1	1	0	0	1	1	0	0	0	0
5	1	1	1	1	1	1	1	1	1	1	1	1
6	1	1	1	1	1	1	1	0	1	1	1	1
7	1	1	1	1	1	0	0	0	0	0	0	0
8	1	0	0	1	1	0	0	0	0	0	0	0
9	1	0	0	0	0	0	0	0	0	0	0	0
10	1	1	1	1	0	0	1	0	0	0	0	0
11	1	1	1	1	1	1	0	0	0	1	1	1
12	1	0	1	0	0	0	0	0	1	0	0	0
13	1	1	1	1	1	1	1	0	1	1	1	1
14	1	1	1	1	1	1	1	0	0	1	1	0
15	1	0	0	1	0	0	0	0	0	0	1	1
16	1	0	1	0	0	0	0	0	0	0	0	0
17	1	0	1	1	0	0	0	0	0	0	0	0
18	1	0	1	1	1	0	0	0	0	0	0	0
19	1	1	1	1	0	0	0	0	0	0	0	0
20	1	0	0	1	1	1	1	0	0	0	0	0
21	1	1	1	1	1	0	0	0	0	0	1	1
Correct	19	10	15	16	12	6	8	2	4	15	7	6
Total	20	20	20	20	20	20	20	20	20	20	20	20
Percentage	95%	50%	75%	80%	60%	30%	40%	10%	20%	75%	35%	30%

<u>Code</u>
0 = incorrect
1 = correct

Control Group

		Questions k =12											
	Students	1	2	3	4	5	6	7	8	9a	9b	9c	9d
	23	1	0	1	1	0	1	0	0	0	0	0	0
	24	1	1	0	0	1	1	0	0	0	1	1	1
	25	0	0	0	1	0	0	0	0	0	0	0	0
	26	1	1	0	0	0	0	0	0	0	1	1	1
	27	0	0	0	1	0	0	0	0	0	0	1	0
	28	1	1	1	0	1	1	0	0	0	1	1	1
	29	1	0	1	1	0	0	0	0	0	0	0	0
	30	1	1	1	1	1	1	0	1	0	0	1	0
Students	32	1	0	1	0	0	0	1	0	0	0	0	1
n = 15	33	1	1	1	1	0	0	0	0	0	0	0	0
	34	1	0	0	1	0	0	0	0	0	0	0	0
	35	1	0	0	1	0	0	0	1	0	1	0	1
	38	1	1	1	1	1	1	0	0	0	1	1	1
	39	1	1	1	1	0	0	0	1	0	0	0	0
	40	1	1	1	1	0	0	0	0	0	0	0	0
	Correct	13	8	9	11	4	5	1	3	0	5	6	6
	Total	15	15	15	15	15	15	15	15	15	15	15	15
	Percentage	87%	53%	60%	73%	27%	33%	7%	20%	0%	33%	40%	40%

<u>Code</u>
0 = incorrect
1 = correct

Appendix D

Posttest Results

Experimental Group

Questions k =15

	Students	1	2	3	4	5	6	7	8	9	10	11	12a	12b	12c	12d
	1	1	0	1	0	0	1	1	1	0	1	1	1	1	0	1
	3	1	0	0	0	1	0	0	1	0	0	0	1	1	1	1
	4	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	5	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1
	6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	7	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1
	8	0	1	1	0	1	1	0	1	1	1	1	1	1	1	1
	9	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1
Students	10	1	1	1	1	0	1	0	1	1	1	0	1	0	1	1
n = 20	11	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	12	0	0	1	1	1	1	1	1	1	1	1	0	0	1	0
	13	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1
	14	1	1	1	1	0	1	1	1	0	1	0	1	0	1	1
	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	16	1	0	1	1	1	1	1	1	0	1	1	1	1	1	0
	17	1	1	1	1	1	1	1	1	1	1	1	0	0	1	0
	18	0	1	1	0	1	1	0	0	0	0	0	0	0	0	0
	19	1	0	1	1	1	1	1	1	0	1	1	0	0	0	0
	20	1	0	1	1	1	1	1	1	0	1	0	0	0	0	0
	21	1	1	1	1	1	1	0	1	1	1	0	1	1	1	1
	Correct	15	12	18	15	16	18	12	18	12	17	13	14	11	15	13
	Total	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
	Percentage	75%	60%	90%	75%	80%	90%	60%	90%	60%	85%	65%	70%	55	75%	65%

Code

0 = incorrect

1 = correct

Control Group

		Questions k =15														
	Students	1	2	3	4	5	6	7	8	9	10	11	12a	12b	12c	12d
	23	1	0	1	1	1	1	0	1	1	0	1	0	0	0	0
	24	0	0	1	1	1	1	0	1	0	0	1	1	1	1	1
	25	1	0	1	0	1	1	1	1	1	1	1	0	0	0	0
	26	1	1	1	1	1	1	0	1	0	1	1	1	1	1	1
	27	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0
	28	0	0	1	1	1	0	1	1	0	1	0	1	1	1	1
	29	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1
	30	1	0	1	1	1	1	1	1	1	1	0	0	1	1	0
Students	32	1	0	1	0	1	1	0	1	1	0	1	1	0	1	1
n = 15	33	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0
	34	1	0	1	1	1	1	0	1	0	1	0	1	1	1	1
	35	0	0	0	0	1	1	0	0	0	0	1	0	0	0	0
	38	1	0	1	1	1	1	1	1	1	1	0	1	1	1	0
	39	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1
	40	1	0	1	0	1	1	0	1	1	1	0	1	1	1	1
	Correct	10	3	12	9	14	14	6	13	8	10	8	9	8	10	8
	Total	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
	Percentage	67%	20%	80%	60%	93%	93%	40%	87%	53%	67%	53%	60%	53%	67%	53%

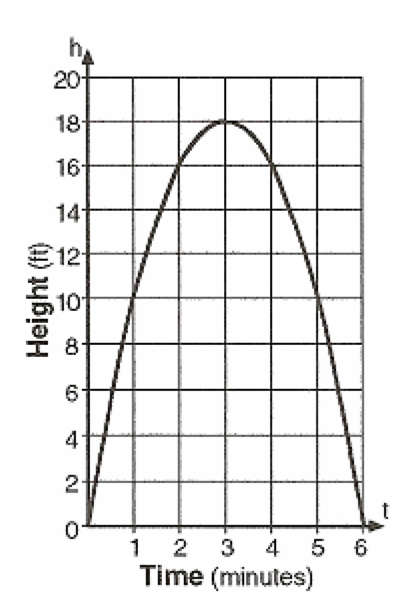
<u>Code</u>

0 = incorrect

1 = correct

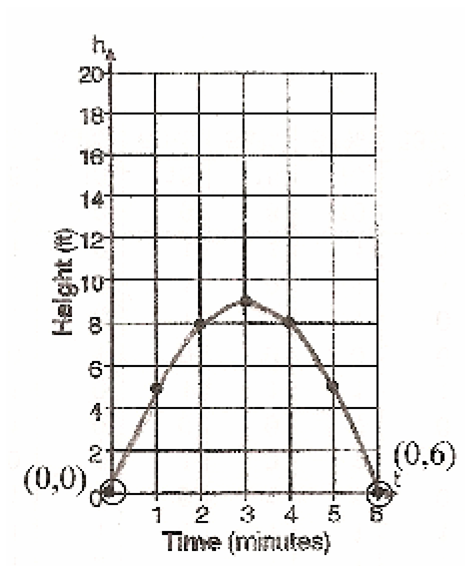
Appendix E
Answers to the Pretest

1. C
2. C
3. D
4. C
5. B
6. k = -9
7. C
8. B
9a. See graph
9b. At 3 seconds the ball is at the highest point.
9c. The maximum height of the ball is 18ft.
9d. The height of the ball at t = 5 is 10ft.



Answers to the Posttest

1. A
2. A
3. B
4. C
5. D
6. B
7. D
8. B
9. D
10. A
11. 8.6m
12a. See graph
12b. The maximum height of the rocket is 9ft.
12c. It takes 3 seconds for the rocket to reach its maximum height.
12d. (0,0) and (0,6)



Appendix F

Interactive Whiteboard Training Survey

Please circle the school district for which you work:

Southern Tier School District Hudson Valley School District

Please answer each of the following questions by circling the choice you feel is the most appropriate for you. A space has been left after each of the questions for your comments pertaining to that question. Comments are welcomed!!

1. The interactive whiteboard (IWB) should be implemented into the classroom.

Strongly agree Agree Undecided Disagree Strongly Disagree

Comments:

2. If an IWB was permanently in your classroom, how often would you use it?

Daily Once a Week 2-3/ Week Bi-Weekly Monthly Never

Comments:

3. After the training session that was offered by my school, I feel that I was adequately prepared to use an IWB in my classroom.

Strongly agree Agree Undecided Disagree Strongly Disagree

Comments:

4. I feel my school district should offer more professional development sessions related to the IWB and its uses within the classroom.

Strongly agree Agree Undecided Disagree Strongly Disagree

Comments:

5. Please indicate which of the following statements best represents your use of an IWB.

a) I do not have an IWB in my classroom.
b) I have an IWB in my classroom, but do not use it.
c) I use an IWB in my classroom only for demonstration purposes.
d) I have an IWB in my classroom and allow students to use it as part of the lesson.

Comments:

6. I feel that the IWB helps students better understand mathematical concepts.

Strongly agree Agree Undecided Disagree Strongly Disagree
N/A

Comments: (Please indicate which concepts you feel the students better understand.)

Appendix G

Hudson Valley School District

1. The interactive whiteboard (IWB) should be implemented into the classroom.

Strongly agree	Agree	Undecided	Disagree	Strongly Disagree
100%				

---

2. If an IWB was permanently in your classroom, how often would you use it?

Daily	Once a Week	2-3/ Week	Bi-Weekly	Monthly	Never
	17%	66%		17%	

---

3. After the training session that was offered by my school, I feel that I was adequately prepared to use an IWB in my classroom.

Strongly agree	Agree	Undecided	Disagree	Strongly Disagree
17%	66%		17%	

---

4. I feel my school district should offer more professional development sessions related to the IWB and its uses within the classroom.

Strongly agree	Agree	Undecided	Disagree	Strongly Disagree
33%	67%			

---

5. Please indicate which of the following statements best represents your use of an IWB.

e) I do not have an IWB in my classroom.
f) I have an IWB in my classroom, but do not use it.
g) I use an IWB in my classroom only for demonstration purposes.
h) I have an IWB in my classroom and allow students to use it as part of the lesson.

A	B	C	D
	33.3%	33.3%	33.3%

---

6. I feel that the IWB helps students better understand mathematical concepts.

Strongly agree	Agree	Undecided	Disagree	Strongly Disagree
17%	66%	17%		

Southern Tier School District

1. The interactive whiteboard (IWB) should be implemented into the classroom.

Strongly agree	Agree	Undecided	Disagree	Strongly Disagree
100%				

---

2. If an IWB was permanently in your classroom, how often would you use it?

Daily	Once a Week	2-3/ Week	Bi-Weekly	Monthly	Never
14%	43%	43%			

---

3. After the training session that was offered by my school, I feel that I was adequately prepared to use an IWB in my classroom.

Strongly agree	Agree	Undecided	Disagree	Strongly Disagree
14%			57%	29%

---

4. I feel my school district should offer more professional development sessions related to the IWB and its uses within the classroom.

Strongly agree	Agree	Undecided	Disagree	Strongly Disagree
29%	71%			

---

5. Please indicate which of the following statements best represents your use of an IWB.

i) I do not have an IWB in my classroom.
j) I have an IWB in my classroom, but do not use it.
k) I use an IWB in my classroom only for demonstration purposes.
l) I have an IWB in my classroom and allow students to use it as part of the lesson.

A	B	C	D
100%			

---

6. I feel that the IWB helps students better understand mathematical concepts.

Strongly agree	Agree	Undecided	Disagree	Strongly Disagree
86%	14%			

Appendix H

Descriptive Statistics

Experimental Group

	N	Range	Minimum	Maximum	Sum	Mean		Std. Deviation	Variance
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic
Posttest	20	100.00	.00	100.00	1420.00	71.0000	6.22770	27.85111	775.684
Prestest	20	84.00	8.00	92.00	936.00	46.8000	6.24188	27.91453	779.221
Valid N (listwise)	20								

Control Group

	N	Range	Minimum	Maximum	Sum	Mean		Std. Deviation	Variance
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic
Posttest	15	73.00	20.00	93.00	970.00	64.6667	6.01796	23.30747	543.238
Prestest	15	75.00	8.00	83.00	609.00	40.6000	5.58297	21.62274	467.543
Valid N (listwise)	15								

ANOVA

Pretest

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	329.486	1	329.486	.509	.480
Within Groups	21350.800	33	646.994		
Total	21680.286	34			

Posttest

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	343.810	1	343.810	.508	.481
Within Groups	22343.333	33	677.071		
Total	22687.143	34			

Difference between Pretest and Posttest

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.038	1	.038	.000	.995
Within Groups	33802.133	33	1024.307		
Total	33802.171	34			

Multiple Linear Regression Test

Correlations

		Posttest	Groups	Pretest	Crsprdt
Pearson Correlation	Posttest	1.000	.123	.242	.158
	Groups	.123	1.000	.123	.868
	Pretest	.242	.123	1.000	.297
	crsprdt	.158	.868	.297	1.000
Sig. (1-tailed)	Posttest	.	.241	.081	.183
	Groups	.241	.	.240	.000
	Pretest	.081	.240	.	.041
	crsprdt	.183	.000	.041	.
N	Posttest	35	35	35	35
	Groups	35	35	35	35
	Pretest	35	35	35	35
	crsprdt	35	35	35	35

Model Summary

					Change Statistics				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	.260(a)	.067	-.023	26.12437	.067	.747	3	31	.532