

The Effects of the Use of Interactive Whiteboards on Student Achievement

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Abstract: The purpose of the research reported in this paper was to investigate whether the use of interactive whiteboards in English language arts and/or mathematics lessons improved student learning in those areas as measured by student scores on state achievement tests. The study examined the reading and mathematics achievement test scores of all students in the third through eighth grades in a small urban school district in northern Ohio and compared scores between students whose teachers used interactive whiteboards for instruction and those whose teachers did not. Results show slightly higher performance among students in the interactive whiteboard group, with students in the fourth and fifth grades exhibiting the greatest advantage for interactive whiteboard instruction. Further research on the use of interactive whiteboards for K-12 teaching and learning is thus clearly indicated.

Background

Current theories of learning emphasize the importance of actively engaging children in the learning process (Bransford, Brown, & Cocking, 1999), and recently there have been a variety of technologies designed to support active engagement in learning. One such technology is the interactive white board. Interactive white boards allow teachers and students to interact with content projected from a computer screen onto a white board surface. Virtually anything that can be done on a computer can be done on an interactive white board, with the advantage that interaction involves fingers and pens and so is more kinesthetic, drawing, marking and highlighting of any computer-based output is supported, a whole class can follow interactions, and lessons can be saved and replayed.

Initial research on the use of interactive whiteboards in both K-12 and higher education is promising. Studies have documented that both teachers and students like the technology (Beeland, 2002; Hall & Higgins, 2005; Kennewell & Morgan, 2003; Smith, Higgins, Wall & Miller, 2005) and that students are more engaged and motivated to learn when whiteboards are employed (Beeland, 2002; Miller, Glover & Averis, 2004, 2005; LeDuff, 2004; Painter, Whiting & Wolters, 2005; Smith, Hardman & Higgins, 2006). In addition, many research studies have noted that use of whiteboards shifts instruction from presentation to interaction and students' focus away from teachers and onto content, making interactive whiteboard lessons more student-centered than traditional ones (Cuthell, 2005; Miller, Glover & Averis, 2003, 2004; Painter, Whiting & Wolters, 2005).

Moreover, there is some evidence that the use of interactive whiteboards can increase student achievement. Zittle (2004), for example, explored the effects of whiteboard lessons on the geometry learning of Native American elementary students by comparing pre- to post-test gains between 53 students whose teachers used interactive whiteboards with 39 students whose teachers did not. He found statistically significant differences between the groups with the interactive white board group obtaining an average gain score of 20.76 and the control group averaging a gain of 11.48. Similarly, Dhindsa & Emran (2006) compared pre- to post-test gains between college classes taught six organic chemistry lessons either with or without interactive whiteboards. The authors found statistically significant gains for students taught using interactive whiteboards, with the interactive whiteboard group averaging a mean effect size of 2.68 and the control group averaging a mean effect size of 2.16.

The promise of the use of interactive whiteboards for increasing student achievement has led schools and school districts across the United States to purchase and install them in K-12 classrooms in the hope that their use will improve student scores on standardized tests. In this paper, we report on research examining the effects of one such implementation. Specifically, the research questions examined were:

Do students whose teachers use interactive whiteboards to assist in math or reading/language arts instruction perform better academically (on standardized tests of mathematics and reading achievement) than those who do not?

Among classes where interactive whiteboards were used, were there differences in usage between classes whose average test scores were above grade level means and those who weren't?

Subjects and Setting

The research took place in a small city school district in northern Ohio as part of a larger evaluation of interactive white board use. The district is in Academic Watch, meaning that a large percentage of its students are achieving below grade level. Because Ohio Achievement Tests (OAT) are given in grades three through eight, the results given here come from a comparison of OAT scores between students whose teachers used interactive whiteboards in mathematics or English language arts instruction in those grades, and students in those grades whose teachers did not use them. The study involved students enrolled in 11 elementary schools, 3 junior high schools, and 1 alternative school. One-third of the school district's student population are minorities, with the largest number (21%) being African-American. Eight percent of the district's students live below the poverty line.

Overall, teachers in the district who had them reported using their interactive whiteboards quite frequently, averaging roughly three times per week. Across schools, subject areas and grade levels they expressed overwhelmingly positive attitudes toward using them. Generally speaking, interactive whiteboard use tended to be more frequent in the elementary grade levels than in later grades for both math and reading. However, the frequency of use of interactive whiteboards for classroom management purposes was more consistent across grade levels. While many teachers simply used their interactive whiteboards as substitutes for chalkboards or overhead projectors, many others reported using them for a variety of purposes, including: displaying charts and graphs, connecting to online activities and sources of information, videoconferencing, preparing for the Ohio Achievement Test, playing educational games, classroom assessment, and student presentations.

Data Sources and Analysis

Data sources for the research were the mathematics and reading scores of all third through eighth grade students in the district on the Ohio Achievement Test (OAT) for the 2006-2007 school year obtained from district administrators. District administrators also provided demographic information for these students, including students' school, teacher(s), grade level, sex, race/ethnicity, and IEP status. In order to determine the relationship between interactive whiteboard use and student achievement in mathematics and reading, the scores of students whose teachers used interactive whiteboards in mathematics and/or English language arts instruction were compared with the scores of students whose teachers did not use them using analysis of variance (ANOVA). Average OAT mathematics and language arts/reading scores for each teachers' students were also computed.

In addition, data concerning teachers' use of interactive whiteboards was obtained through an online survey completed weekly (for 10 weeks) by teachers using whiteboards in their classes from February, 2007 through April, 2007. Data collected through these self reports included the frequency of interactive whiteboard use in mathematics, in reading/language arts, and/or for classroom management. Respondents were also asked to note effective or otherwise interesting uses made of interactive whiteboards during the previous week in mathematics instruction, in reading/language arts instruction, and/or for classroom management. Out of a total of 142 teachers using interactive whiteboards in the district, weekly responses varied from between 30 and 67, although because not all teachers replied each week, a majority of the teachers responded at least once a month.

To explore potentially more effective uses of whiteboards, whiteboard teachers whose students scored above overall means on standardized tests of mathematics and/or reading were identified. These included 13 teachers whose students' scores were higher than the general mean in reading, 11 teachers whose students' scores were higher than the overall mean in mathematics, and 6 teachers whose students' scores were higher than the mean in both reading and mathematics. Self-report data for these teachers was descriptively compared with self-report data from teachers who used interactive whiteboards but whose students scored at or below the general mean in reading and/or mathematics. Firstly, weekly frequency of whiteboard use was averaged for each teacher across the ten week reporting period and then average use compared between high achieving teachers and all others in three categories – frequency of use for mathematics instruction, frequency of use for reading instruction, and frequency of use for classroom management. In addition, teachers' comments concerning whiteboard usage in each category were qualitatively examined for themes and trends and similarly compared between high achieving and average and/or below average classes.

Results

In the sections which follow, findings from statistical comparisons of standardized test scores between students whose teachers employed interactive whiteboards and those whose teachers did not are summarized -- first in terms of reading performance, and then for mathematics performance. Descriptive comparisons between high achieving whiteboard classes and other classes using the technology are then explored.

Reading Achievement

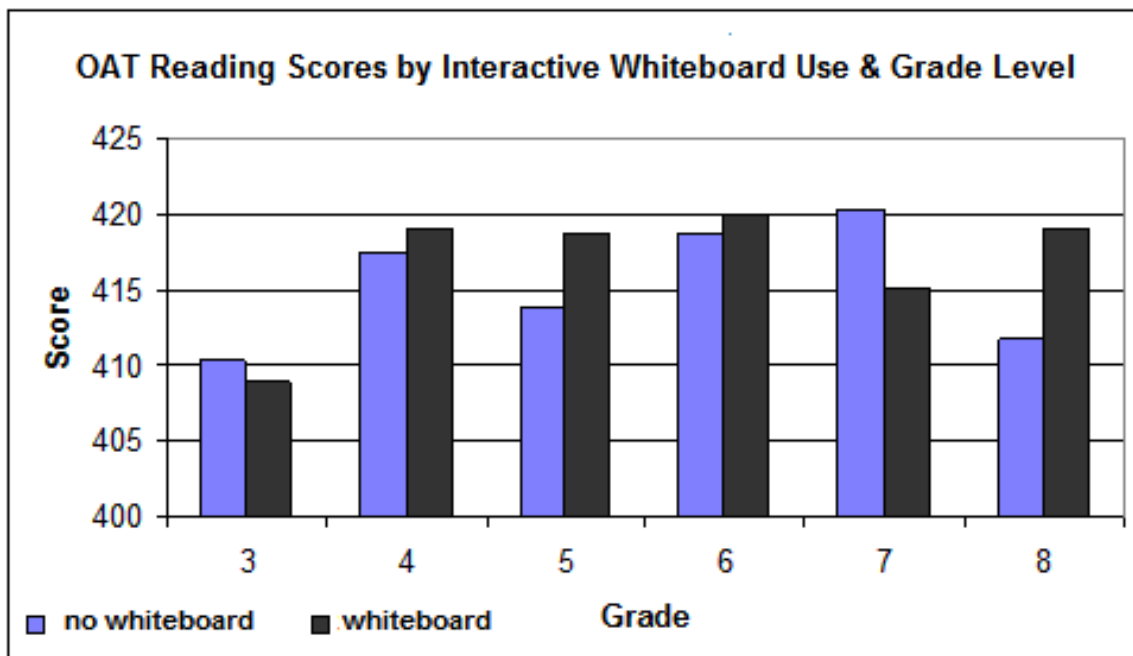


Figure 1:
Comparison of Standardized Reading Scores Across Grade Levels by Whiteboard Usage

A total of 1466 students in the data set were enrolled in the classes of the 35 teachers who used interactive whiteboards for reading/English language arts instruction in grades three through eight, while 1686 students were enrolled in the classes of the 55 teachers who did not use interactive whiteboards in those grades. When comparing students whose teachers used interactive whiteboards for reading instruction to those whose teachers did not, the interactive whiteboard group performed slightly better ($m = 416.95$) on the Ohio Achievement Reading Tests than the group that did not use interactive whiteboards ($m = 415.55$) across all grades. This

difference was not statistically significant, $F(1, 3128) = 1.477, p = 0.224$. However, a statistically significant interaction was found between interactive whiteboard use and grade in school, $F(1, 3128) = 2.238, p = 0.048$. As shown above (Figure 1), students in reading/English language arts classes with interactive whiteboards outperformed students in classes without them on Ohio Achievement Tests of reading in all grades except grades 3 and 7. No interaction between gender and interactive whiteboard use or gender, grade level and interactive whiteboard use were found.

Mathematics Achievement

A total of 1379 students in the data set were enrolled in the classes of the 31 teachers who used interactive whiteboards for mathematics instruction in grades three through eight, while 1813 students were enrolled in the classes of the 43 teachers who did not use interactive whiteboards in those grades. When comparing students whose teachers used interactive whiteboards for mathematics instruction to those whose teachers did not, the interactive whiteboard group performed slightly better ($m = 415.81, n = 1379$) on the Ohio Achievement Mathematics Tests than the group that did not use interactive whiteboards ($m = 414.63, n = 1813$) across all grades. This difference was statistically significant, $F(1, 3168) = 5.591, p = 0.018$. Additionally, there was a significant interaction between interactive whiteboard use and grade, $F(5, 3168) = 2.925, p = 0.012$. As shown below (Figure 2), students in mathematics classes with interactive whiteboards outperformed students in classes without them in all grades except grade 6.

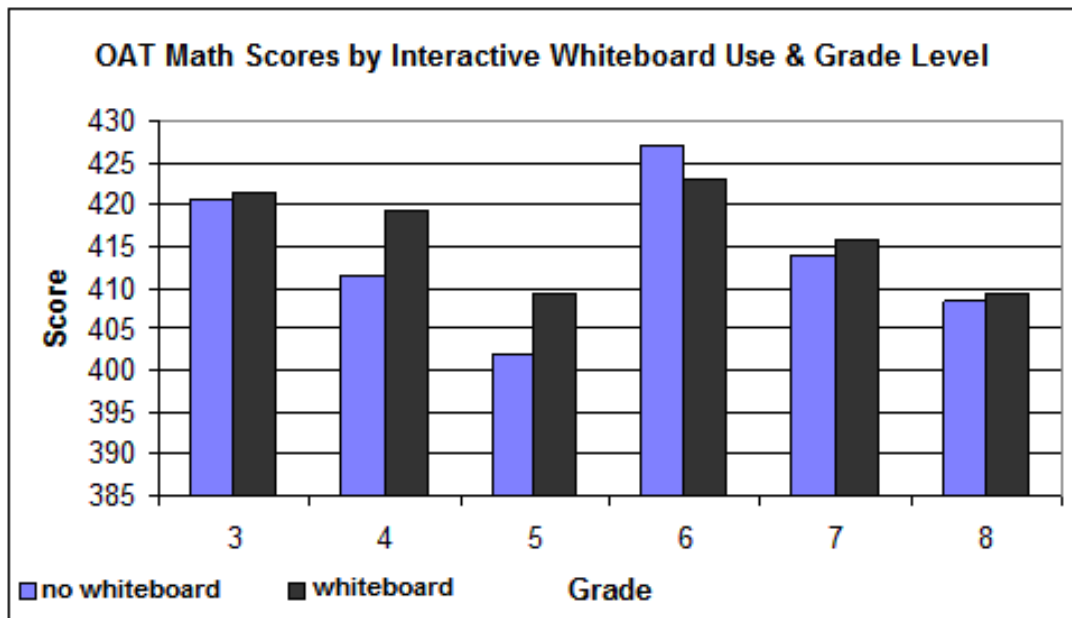


Figure 2:
Comparison of Standardized Mathematics Scores Across Grade Levels by Whiteboard Usage

No interaction between gender and interactive whiteboard use or gender, grade level and interactive whiteboard use were found.

Whiteboard Use

As considerable variance in the effects of interactive whiteboard usage was found, we decided to look more closely at the ways interactive whiteboards were used in classes to determine how they might be used most effectively.

Whiteboards were used slightly more often in mathematics teaching than in the teaching of reading/language arts, and they were generally used a little less for classroom management than for either mathematics or language arts teaching. To explore possible differences in frequency of use of interactive whiteboards between

high achieving whiteboard classes and other classes using the technology, teachers whose average student scores were higher than the mean for all whiteboard classes on standardized tests of mathematics and reading were identified. Frequency of whiteboard use among these teachers for mathematics instruction, reading instruction, and classroom management was compared with frequency of use among teachers whose students scored at or below the mean on the same standardized tests.

There was no difference in frequency of use for classroom management between these two groups. Average use of interactive whiteboards for classroom management was three times per week in both groups. However there was a considerable difference in the frequency of whiteboard use for instruction between groups (Figure 3). The teachers of students who scored above the mean on standardized tests of mathematics performance reported using interactive whiteboards an average of 4.7 times per week, while the teachers of students who scored at or below the mean on the mathematics test reported using them only 3.1 times per week on average. Similarly, teachers of students who scored above the mean on standardized reading/language arts tests reported using interactive whiteboards an average of 4.6 times per week, while the teachers of students who scored at or below the mean in reading reported using them an average of 2.9 times per week.

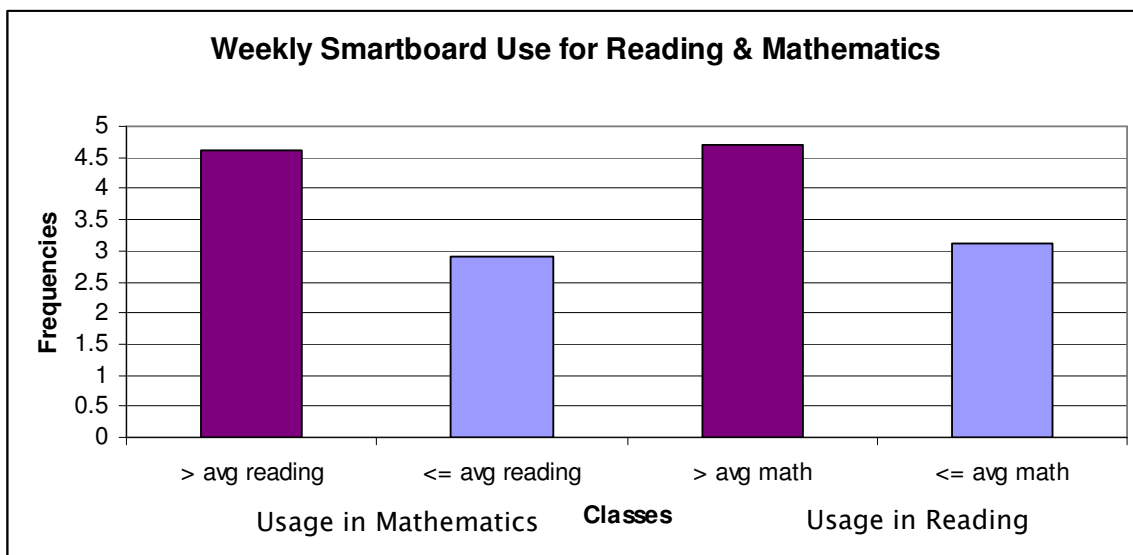


Figure 3:
Comparison of Frequencies of Whiteboard Usage in Reading and Mathematics by Average Test Scores

Teachers' descriptions of the uses they made of interactive whiteboards were qualitatively analyzed for emerging themes. In the paragraphs that follow, themes that emerged in the general categories of whiteboard functions employed and instructional uses made of them in first mathematics and then reading/language arts will be compared between teachers whose students scored above the mean on standardized tests in each subject area and teachers whose students scored at or below the mean.

In mathematics classes, teachers reported using whiteboards for simple display, for displaying interactive charts, graphs, and manipulatives, and to connect to the Internet to access information and interactive activities. These whiteboard functions were employed for motivation, to present subject matter, to support preparation for standardized tests, to play games, and to facilitate whole group practice and/or assessment activities.

Teachers whose students scored above the mean on standardized mathematics test were more likely to use white boards interactively and to focus whiteboard activities on visualization of concepts and processes, most especially problem solving. For example, elementary teachers noted,

“Students worked with pattern blocks on the board to build fractions using different values. ie triangle = 1/4 build a polygon worth 3 3/4; hexagon = 1 what is the value of two rhombuses + 3 trapezoids? etc.”

"I've been using it to show students how to get to web-sites for problem solving. We also use the strategies of how to "think through" a problem by modeling it with the actual problems the kids are doing on paper. We did several strategy puzzles too".

Similarly, a high school teacher reported,

"I used it to teach solving and graphing an inequality on a coordinate graph. I also have my students go to the SmartBoard and complete the x/y table and graph the results."

The teachers of high achieving mathematics classes also seemed more likely to encourage their students to become active participants in the teaching and learning process. Two teachers in this group, for example, had students create math games they shared with their classmates. One teacher commented,

"This type of medium holds interest more than any other I've used in 28 years of teaching. Children take to it so quickly and come up with ideas and alternatives in lessons that I have prepared that we can change on the spot."

In contrast, although teachers whose students scored at or below the mean on mathematics assessments also were most likely to use the interactive features of whiteboards, they tended to use these for more teacher-centered activities. For example, mathematics teachers in this group reported,

"We are in the fractions unit. I designed a Power Point presentation called "Fraction Action" to encourage students to get more excited about fractions."

"I used the ruler to demonstrate how to line up for measuring and explained 1/2 inch".

Teachers in this group also seemed to use whiteboards to access Internet activities, such as math games, more than teachers in the high achieving group. Moreover, many of them commented on the motivational aspects of interactive whiteboard use, whereas none of the teachers with high achieving students did. One teacher in this group wrote, for example,

"The SmartBoard serves as an incredible incentive for positive behavior. My students are well aware that coming to the SmartBoard is a privilege and only students who are quiet and follow instructions are allowed to engage in this activity."

In reading/language arts classes, teachers reported using whiteboards for simple display, for displaying graphic organizers, for connecting to the Internet to access information and online activities, and for videoconferencing. These functions were employed for motivation, to present subject matter, to support preparation for standardized tests, to play games, for student presentations, and to support special needs students.

Perhaps even more so than in mathematics, the contrast between teachers whose students scored above the mean on state assessments and teachers whose students scored at or below the mean seemed to be between student-centered and teacher-centered uses of the whiteboards. For example, teachers whose students scored above the reading/language arts mean were more likely to use whiteboards to support student presentations:

"Students gave Power Point presentations they created for a book share, using Inspiration webs and propaganda techniques to persuade others to read the books."

while teachers whose students scored at or below the mean were more likely to use it in their own presentations. Teachers of high achieving students also tended to use the whiteboards to support visualization of concepts with activities such as concept mapping, brainstorming, and interactive editing. They also used their whiteboards in incredibly creative ways including for videoconferencing with other classes to support group work over distance and for developing and presenting poetry as music videos.

In contrast, teachers whose students scored at or below reading/language arts means often used the whiteboards for simple display of assignments, vocabulary words, and worksheets. Many of these teachers used it to play a variety of language games and many used its timer function for timed seatwork.

Discussion

The results of this study show a small achievement increase among students whose teachers used interactive whiteboards for reading/language arts and mathematics instruction. The increases were quite small, and statistically significant only in mathematics. While the achievement gains found were small, the number of students involved in this study and the fact that the analysis looked across schools and grade levels suggest that they are real. Indeed, positive results were especially pronounced at the fourth and fifth grade levels and significant interactions between achievement gains and grade levels were found in both mathematics and reading/language arts. In addition, when teachers were grouped by their students' mathematics and reading/language arts performance, teachers whose students scored above the mean on both assessments were found to use the whiteboards more frequently (almost every day) than the teachers whose students scored at or below the means on these tests. The findings thus clearly indicate the use of whiteboards should be further investigated, with a particular emphasis on their most effective uses. Indeed, our very preliminary exploration of most effective uses of the technology suggests that these may relate to taking advantage of the more unique capabilities of whiteboards, in particular their ability to support visualization and interactivity, and using whiteboards for more student-centered activities. These possibilities should definitely be explored.

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