Student Engagement, Visual Learning and Technology: Can Interactive Whiteboards Help?

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Abstract: The purpose of this action research study was to determine the effect of the use of interactive whiteboards as an instructional tool on student engagement. Specifically, the desire was to see if student engagement in the learning process is increased while using an interactive whiteboard to deliver instruction. In addition, an effort was made to determine if methodology impacts the level at which students are engaged in the learning environment when a whiteboard is used in the classroom. In other words, does the manner in which the whiteboard is used affect the level of student engagement?   A total of ten middle school teachers and 197 students participated in the study.   In each of the ten classes, the teacher presented a lesson using an interactive whiteboard. After the lesson, students were given a survey, and some students completed a questionnaire. Teachers also completed a survey and questionnaire. The results of the surveys and questionnaires indicated a strong preference for the use of interactive whiteboards in the classroom. The results will be used to make further technology spending decisions at our school.

Introduction

As the Instructional Technology Coordinator and School Improvement Steering Committee Chairperson, I am responsible for identifying ways that technology can be used to improve the learning environment for teachers and students at our school. The goal is to create learning environments where students are actively engaged in the learning process. Student engagement is one of most important factors that affect teaching and student motivation to learn.   When students are apathetic toward learning, a barrier to learning is created. One current method of delivering instruction that may assist with engaging students in the learning process is the use of interactive whiteboards.   Thus far, our school has invested in six interactive whiteboards, along with the computers and projectors necessary to operate them, at a cost of approximately six thousand dollars each. Our school is interested in continuing to invest in whiteboards only if this technology is making a positive difference in the teaching and learning environment for our teachers and students.

The whiteboard can be used to deliver instruction in a variety of ways that may be categorized based on three modalities of learning. The first modality is visual learning. Visual learning through the use of a whiteboard can range from the use of text and pictures to the use of animation and video. Auditory learning is the second modality. Activities that involve auditory learning include the use of words orally for pronunciation, speeches, and poems. The use of auditory learning might also include listening to sounds or music. The third modality of learning is tactile.   Allowing students to physically interact with the board can assist with meeting the needs of tactile learners. Numerous software programs can be used that involve user contact with the whiteboard. The extent to which each of these three modalities is incorporated into a lesson may determine the extent to which students are engaged in the learning process and, thus, are motivated to learn.

My hypothesis was that instructional approaches using an interactive whiteboard will increase the level of student engagement during the learning process in the classroom. Furthermore, the extent to which students will be engaged will be determined by the number of learning modalities used by the teacher and the richness of those uses.

Literature Review

Of the many forms of technology now available for use by teachers with their students in the classroom, interactive whiteboards may provide a significant potential for meeting the needs of students with diverse learning styles and for engaging students during the learning process. The interactive whiteboard is a technology medium that began to be used in classrooms in the late 1990's. Whiteboards generally range in size from forty-two inches to

seventy-two inches diagonally. The boards can be wall-mounted or placed on a separately purchased stand. Whiteboards allow teachers and students to interact with technology in a manner that was not previously possible. The touch-sensitive board allows users to interact directly with applications without having to be physically at the computer which is projecting the image onto the board. Elements of text, graphics, sound, animation, and video help teachers create lessons that interest and engage students during the learning process (Biology, 1999). In addition to information derived from software and the Internet, information can be typed using a computer keyboard or handwritten directly on the board using a wide range of colors and saved for future use. Whiteboards utilize a synchronous transmission mode. Synchronous transmission modes provide two-way interaction between the teacher or student and the medium. This level of participation allows a wider range of participation by the student, leading to an increased state of engagement, and an enhanced learning environment (Bryant & Hunton, 2000). Whiteboards also have an asynchronous function, allowing captured material to be shared on paper or electronically at a later time.

Student engagement is critical to student motivation during the learning process. The more students are motivated to learn, the more likely it is that they will be successful in their efforts. Numerous factors influence student motivation including parental involvement, teacher motivation and skills, and effective use of technology. Technology can be utilized to create a motivating classroom environment where students are engaged in learning. An environment where technology is used in innovative ways leads to improved learning and teaching (Wishart & Blease, 1999). Classroom learning is also enhanced through the use of visuals. Visuals promote a student's ability to organize and process information (McKendrick & Bowden, 1999). Visuals can also be utilized to challenge students to think on levels that require higher order thinking skills (Smith & Blankinship, 2000). Finally, technology provides opportunities for teachers to meet the needs of students with various learning styles through the use of multiple media (Bryant & Hunton, 2000).

The purpose of this action research study was to determine the effect of the use of the interactive whiteboard as an instructional tool on student engagement. Specifically, the following research questions were addressed:

1. Does the use of an interactive whiteboard as an instructional tool affect student engagement?
2. Does the method in which an interactive whiteboard is used as an instructional tool in the classroom affect the degree to which students are engaged?

Methods

In order to address whether or not an interactive whiteboard engages students during the learning process, data was collected as individual teachers used whiteboards in their classrooms. At our school, teachers utilize whiteboards in their classrooms by signing-up on a calendar in the school media center. The ten teachers who participated in this study were chosen based on who had signed up to use a whiteboard and on who was willing to participate in the study. Teachers were also chosen based on the researcher's availability to be present in the classroom to collect data on the day the teachers had signed up to use a whiteboard. Once a teacher was chosen to participate in the study, the appropriate consent forms were completed and filed. Consent was sought and obtained from school and school system administration, the teachers involved, and from students and their parents. The total number of student participants who completed surveys was 197. The total number of students who completed questionnaires was 20.

Student engagement and motivation to learn was measured using two instruments. First, a survey, based on a modified version of the Computer Attitude Questionnaire originally created by Dr. Rhonda Christensen and Dr. Gerald Knezek (Christensen & Knezek, 1997), was given to students immediately following the use of the whiteboard in class. The information from this survey was used to determine student attitude toward the use of a whiteboard in the classroom. In addition, student attitude toward the use of a whiteboard in the classroom was measured by having two students from each class complete a questionnaire. The teacher was asked to identify one student who most likely enjoyed the use of the whiteboard and one who most likely did not. The modalities addressed by the methods that teachers utilized in conjunction with the whiteboard were also recorded. The researcher used a form to record this information while the teacher was conducting class; the information recorded identified which learning modalities (visual, auditory, and tactile) were addressed through the use of the whiteboard. Teacher attitude toward using the whiteboard as a means of delivering instruction was measured using a modified version of the Teachers' Attitudes Toward Information Technology instrument originally created by Dr. Rhonda Christensen and Dr. Gerald Knezek (Christensen & Knezek, 1997). In addition, questionnaires were completed by

teachers in order to determine why they choose to use the whiteboard as a means of delivering instruction, as well as why they chose particular methods of using the whiteboard.

The data collected from surveys and questionnaires was analyzed to determine the level to which students were engaged during the lesson being taught using the whiteboard. The results were then compared to the data collected on the record of whiteboard use form to determine if there is a connection between the levels at which students were motivated to learn and the method in which the whiteboard was used to deliver instruction. The teacher surveys and questionnaire results were analyzed to determine teacher attitudes toward using the whiteboard as an instructional tool.

Results

The dependent variable in this study was student engagement in the learning process when a whiteboard is used in the classroom as an instructional tool. Engagement was measured as students responded to each of twenty survey questions on a 1 to 4 scale. A response of 1 indicated that the student strongly disagreed with the statement, 2 signified disagreement, 3 agreement, and 4 strong agreement. Figure 1 below indicates the average rating of the responses for each question.

Question	Average rating	Standard deviation
1. I enjoy learning with a whiteboard.	3.8	0.10
2. I do not (do) like receiving instruction through a whiteboard.*	3.5	0.18
3. I will be able to get a good job if I learn how to use technology.	3.5	0.11
4. I concentrate better in class when a whiteboard is used to deliver instruction.	3.4	0.15
5. I would work harder if my teacher used the whiteboard more often.	3.2	0.22
6. I know that using technology gives me opportunities to learn many new things.	3.6	0.12
7. I can learn many things when my teacher uses a whiteboard.	3.5	0.14
8. I enjoy lessons on the whiteboard.	3.7	0.08
9. I believe that the more often teachers use whiteboards, the more I will enjoy school.	3.4	0.18
10. I believe that it is important for me to learn how to use a whiteboard.	3.2	0.11
11. I feel comfortable using a whiteboard.	3.5	0.11
12. I enjoy using the whiteboard.	3.7	0.14
13. I (do not) think that it takes a longer amount of time to learn when my teacher uses a whiteboard.*	3.4	0.14
14. Using a whiteboard does not scare me at all.	3.5	0.22
15. Using a whiteboard (does not make) makes me nervous.*	3.5	0.21
16. Using a whiteboard is (not) very frustrating.*	3.5	0.20
17. I will (not) do as little work with technology as possible.*	3.6	0.14
18. Whiteboards are (not) difficult to use.*	3.5	0.19
19. I can(not) learn more from books that the whiteboard.*	3.3	0.16
20. I (do not) get a sinking feeling when I think of trying to use a whiteboard.*	3.7	0.10
Averages	3.48	0.15

*The scoring scale for questions 2, 13, 15, 16, 17, 18, 19, and 20 was reversed. The reversed form of the question is in parenthesis.

Figure 1: Average rating of the responses for each question

On a separate survey, teachers were asked to rate the extent to which they felt delivering instruction using a whiteboard met each of ten qualities related to student engagement. Each quality was rated on a scale of one to seven, with seven representing the positive end of the scale. The results of the teacher survey are included in figure 2.

Quality	Important	Interesting	Relevant	Exciting	Means a lot	Appealing	Fascinating	Valuable	Involving	Needed	Avg.
Rating 1 to 7 scale	6	6.8	6.8	6.6	6.3	6.8	6.2	6.4	6.7	6.2	6.48
St. dev.	0.94	0.42	0.42	0.70	0.82	0.42	1.03	0.70	0.67	0.92	0.71

Figure 2 : Teacher survey

Two students from each of the ten classes who participated in this study also completed open-ended questionnaires. The questions and information regarding student responses are included in the following paragraphs.

Q1. Describe what you like most when a whiteboard is used in the classroom. Most of the students indicated that they liked being able to touch-activate applications on the boards, as well as being able to write on it with pens or even with their fingers. In addition, one student commented, "I concentrate a lot harder when we use the whiteboard. It teaches us a lot, but it's lots of fun."

Q2. Describe what you like least when a whiteboard is used in the classroom. If you could change one thing about the way the whiteboard is used in the classroom, what would it be and why? Students mentioned a variety of things in relation to these questions. Several indicated that it was distracting when someone bumped into either the cart with the projector, or into the board, and the board had to be oriented again. Others mentioned that they felt the board was somewhat difficult to write on because of a shadow effect caused when their hand blocked the light from the projector. The researcher's classroom observations noted some had difficulty touching the board with only the tip of the markers, which caused stray marks to be created on the board. One student stated, "I least like the board when you try to write. When you touch the board with your arm, it makes lines you didn't mean to make." When word processing programs were used, some students mentioned difficulty being able to read the text on the board. Other things that students mentioned they would change included the size of the legs on the stand that holds the board and the cords that run across the floor to connect the computer to the whiteboard, to the network, and to a power source.

Q3. Do you believe you are able to learn better when a whiteboard is used in the classroom? All of the students responded affirmatively to this question except one. The one student who did not report positive effects commented, "I don't think so because I was brought up learning from books so it is going to take getting used to." Students who responded affirmatively mentioned that they felt they learned better because the visual aspects of the whiteboard made it easier to understand what the teacher was teaching. They also mentioned that, when the teacher used the whiteboard, the lessons were much more interesting. For example, one student stated, "It makes me pay attention to the teacher more. When the teacher just stands up there and talks, I get easily distracted."

Q4. Does the use of a whiteboard in the classroom help you to be able to pay better attention? Why or why not? All but one of the students who completed a questionnaire responded that they felt they were able to pay better attention when a whiteboard was used in their classrooms. Most of the comments were related to the visual and interactive nature of the board. One student stated, "I am sometimes not able to understand the book. The teacher explains it better when the whiteboard is up there." Another student responded, "Yes, because you get to participate with it more than just regular classwork." However, one student stated, "Yes and no. I like the board because it's not your everyday blackboard. It's fun to use but can be frustrating."

Q5. Did the visuals projected on the board help you to better learn the information? Why or why not? Many of the students responded that seeing the information helped them to understand it better. As an example, two of the students provided almost identical quotes, "To some people, when you speak to them, it goes in one ear and out the other. The visuals help it to stick."

Q6. Did the use of sound help you to better learn the information? Why or why not? Not many students responded to this question because sound was used in only six of the ten classrooms. Of those responding, most indicated that the use of sound made the lessons more interesting. One student stated, "Yes because it made it more fun to listen to and it wasn't at all boring."

Q7. Does having the opportunity to touch and interact with the board affect your learning? Why or why not? All students responding to this question, except one, mentioned that the use of touch affected their learning in a positive way. One student stated, "Yes, I get into learning when it's hands-on. When I just listen, I don't understand as well." Other students mentioned that touching the board made their learning experiences more fun and interesting. One student did comment, "It really doesn't do anything. I still learn about the same."

In addition to the student questionnaires, each of the ten teachers also completed an open-ended questionnaire. The themes of the questions and a sample of teacher responses are included below:

Q1. What do you like most about teaching with a whiteboard? In response to this question, most teachers used terms and phrases such as "engaged," "very attentive," "active participation," and "increased student interest" to describe the difference in student involvement when lessons were delivered using a whiteboard. In addition, teachers mentioned being able to vary instruction by using the Internet and interactive software, as well as video and sound. One teacher stated that the whiteboard helped to make "current events come to life." Another teacher commented, "Students' attention is automatically on the lesson, no matter what the subject. As soon as they enter the room and see the board, they are immediately interested in what you have planned for class that day." Still another teacher commented, "I enjoy seeing my students engaged. When I use the whiteboard, I tend to stay away from lecturing. The whiteboard makes it easier to be a facilitator and allows the students more freedom to teach and learn from each other." The teachers also mentioned the convenience of being able to save notes and other information to be used in the future.

Q2. What do you like least about teaching with a whiteboard? What issues, if any, do you feel need to be resolved for the whiteboard to be a more effective tool in the classroom?
Most of the comments made by teachers were related to having to reorient the board if the cart holding the computer and projector, or the whiteboard itself, were moved. A couple of teachers mentioned that there was a slight glare from the projector, and that a shadow cast from your hand when you try to write makes the process of writing on the board more difficult. Another teacher mentioned that her classroom was small and that the whiteboard took up a lot of room. One teacher commented, "Of course, if there are problems with the technology aspect that I don't know how to correct, I feel very unprepared and feel like I always need a backup plan. It can be very frustrating to not know how to fix something or operate some component." Other comments were related to the teacher and students tripping over the legs of the stand and having to be mindful of cords going across the floor. Many of the comments made in response to this question were followed by suggestions related to providing a permanent, wall-mounted whiteboard with a ceiling mounted projector in each classroom.

Q3. Do you believe using the whiteboard affects the extent to which students are engaged in the learning process in your classroom? All of the teachers felt that the whiteboard did improve student engagement during the lesson taught using a whiteboard. Most of the teachers attributed this to the students being able to see the information, touch the board, and, in some cases, being able to hear sounds. One teacher commented, "Yes, because I think students can see the whiteboard better than a chalkboard or overhead transparency, and the whiteboard engages them more. Also, students, especially middle school age, love the opportunity to get out of their desks, touch things, tap things, and show off. The whiteboard is great for this kind of engagement." Another commented, "After one lesson with the board, I feel confident that 99% of my students were engaged in the lesson. It is especially effective with teaching classes who are working below grade level."

Q4. Do you believe the use of a whiteboard in the classroom contributes to learning? Why or why not?
All of the teachers responded that the whiteboard does contribute to learning because it increases the attention level of students. One typical comment was that, "the use of the whiteboard contributes to learning because today's students seem to be very visual and enjoy hands-on activities. The whiteboard allows for both, and students become more involved." Another responded, "It contributes to learning because it helps to get students interested, and anything that interests them and keeps their attention helps them learn. It's also a tool that easily lets students actively participate and gets them involved in the lesson."

Q5. In what ways, if any, does a whiteboard address the three modalities of learning: visual, auditory, and tactile? All of the teachers recognized the use of graphics, animation, and video as helping to meet the visual needs of students. They also recognized that allowing students to interact with the board themselves positively impacted the needs of tactile learners. While not all teachers utilized sound when teaching with the whiteboard, all recognized that the auditory needs of students were also positively impacted either through software or the dialogue created between teachers and students when the whiteboard is used.

Discussion

The purpose of this action research study was to determine the effect of the use of interactive whiteboards as an instructional tool on student engagement. Specifically, to see if student engagement in the learning process is increased while using an interactive whiteboard to deliver instruction. In addition, an effort was made to determine

if methodology impacts the level at which students are engaged in the learning environment when a whiteboard is used in the classroom.

The first research question addressed in this study was: Does the use of an interactive whiteboard as an instructional tool affect student engagement? The unequivocal answer, based on the results of both the surveys and questionnaires, is yes. On the student survey, there were no questions that were rated anything less than a three (agree). The average for all twenty questions from all ten classes was 3.48 or midway between "agree" and "strongly agree". The statements with which the students agreed most often were all related to enjoying using the whiteboard in the classroom (questions 1, 8, 12, 20). The same results were apparent on the teacher survey. Teachers rated each of ten qualities related to using the whiteboard in the classroom on a one to seven scale, with seven being at the positive end of the scale. Of the ten qualities measured on the survey, none received less than an average score of six. The characteristics that were rated the highest were that instruction delivered using a whiteboard was interesting (6.8), relevant (6.8), appealing (6.8) and involving (6.7). All of these are characteristics that contribute to increased student engagement. The characteristics that were rated the lowest were that instruction delivered using a whiteboard was important (6), fascinating (6.2), and needed (6.2). While these three characteristics were rated the lowest, they each still received an average rating of six or better out of seven.

The second research question addressed in this study was: Does the method in which an interactive whiteboard is used as an instructional tool in the classroom affect the degree to which students are engaged? The answer to this question was determined by comparing how the whiteboard was used in the classroom to the student responses on the survey. The manner in which the teacher used the whiteboard was recorded on a form based on the observations of the researcher. Data that was recorded included the frequency with which text, graphics, video, and sound were used during the course of the lesson. In addition, the number of times that students and the teacher made physical contact by touching the board was recorded. Based on the results of the student survey, there was a correlation between how highly the whiteboard was rated based on the type of media that was used, but not based on how much the students were allowed to interact with the whiteboard. Somewhat surprisingly, four of the five classes that ranked the use of the whiteboard the highest (3.5, 3.5, 3.54, 3.55) were the four classes where students were allowed to interact with the board the least. As a matter of fact, in two of the four classes, students did not have an opportunity to touch the whiteboard at all. However, it was also these classes that made the best use of multimedia. The activities in these classes included interactive math software where students viewed a video and then used math to rescue a lost camper in the woods, the use of video transmitted over the Internet to study current events, the use of an interactive PowerPoint Jeopardy review board to review concepts learned in a science class, and the use of Inspiration software to create a literature story concept map. Among the four classes, only six students touched the board a total of seventeen times. In the remaining six classes, the ratings of the whiteboard by students were almost identical (3.43, 3.44, 3.43, 3.46, 3.4), with the exception of one class (3.51). The activities in these classes centered mostly on the use of text. The activities included either correcting grammatical mistakes in a typed article or completing analogies. It must be noted here that it is possible that the nature of the activity, the accompanying software and the level of engagement built into the lesson may have been factors that contributed to the positive effect, in addition to or rather than the whiteboard in these lessons.

The results of this study indicate that interactive whiteboards can be used in the classroom to increase student engagement during the learning process. This information will be helpful to schools and school system leaders as important decisions are made regarding future spending of technology funding. The findings of this research will be disseminated to teachers and to building and system level administrators. Based on the results of this study, I would recommend that interactive whiteboards be purchased with the intention that they be permanently housed within a classroom. Doing so will eliminate many of the reservations that teachers and students had about using whiteboards in the classroom. Specifically, wall-mounted whiteboards and ceiling-mounted projectors in individual classrooms would eliminate teachers and students tripping over the legs of whiteboard stands and the cords that would otherwise run along the floor. These would also eliminate the need to reorient the board due to the board or the projector being bumped accidentally. The negative factors in configuring classrooms with wall-mounted whiteboards and ceiling-mounted projectors include the amount of funds necessary to facilitate each room with the equipment, and the fact that the whiteboards and projectors could then no longer be shared among classrooms.

There are many issues related to the use of the whiteboard in the classroom that still need to be examined. First of all, before resources are utilized to begin permanently placing whiteboards in classrooms, information needs to be gathered on whether or not all teachers prefer to have whiteboards in their classrooms. There is no need to begin spending funds on placing whiteboards in the classrooms of teachers who do not prefer or plan to use them. One factor that may be involved with this issue is whether or not teachers feel adequately trained to integrate whiteboards, and technology in general, into their curricula. On the issue of resources, it would also be appropriate

to study methods of obtaining the funding to place more whiteboards into classrooms. Finally, it must be noted once again that it is possible that the nature of the activities, the accompanying software programs and the level of engagement built into the lessons may have been factors that contributed to the positive effect of whiteboard use in this study, in addition to or rather than the whiteboard itself. Therefore, more study would need to be conducted on the types and natures of lessons that are delivered in conjunction with the use of whiteboards.

The results of this study indicate that the use of interactive whiteboards in the classroom does lead to increased student engagement. The primary reason appears to be the visual aspects of using the whiteboard. Therefore, school and technology leaders need to be aware of the potential these whiteboards have for increasing student achievement through increased student engagement. Effectively using this information, in conjunction with other school improvement efforts, has the potential to greatly assist educators in their efforts to attract and maintain student attention and to improve student achievement.

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