The effects of using an interactive whiteboard on the academic achievement of university students

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Abstract

The aim of this study was to identify the effects of the use of an interactive whiteboard on the academic achievement of university students on the topic of electricity in a science and technology laboratory class. The study was designed as a pretest/posttest control group experimental study. Mean, standard deviation and t-tests were used for data analysis. An independent groups t-test was used to test for the differences between the pretest and posttest mean of experimental and control group. No significant difference was observed between the academic achievement of the students in the experimental group, who were taught with both interactive whiteboard and laboratory practices, and the control students, who experienced only laboratory practices. The posttest standard deviation values in the experimental group were relatively lower than those in the control group. The electric motor, electric bell, and generation of the induction current models were prepared on the computer by the researchers using Macromedia Flash 8, and its application was undertaken by the students on the interactive whiteboard (smart board). It was seen that although interactive whiteboard use might not significantly alter students' academic achievement, it encouraged them to participate more in the lesson, created an interesting and enthusiastic atmosphere, and led to more enjoyable lessons. At the same time, many students from the experimental group stated that the interactive simulations and virtual experiments were superior to real experiments and enabled them to better visualize the topic.

Keywords: Interactive whiteboard, virtual experiments, science education

1. Introduction

Today, radical changes are being introduced in cultural and social life by computers that store, retrieve and process information and the Internet that connect computer and people. Computer applications such as educational games, virtual reality, simulations, multimedia applications and e-books are making significant contributions to the teaching and learning process. Furthermore, the acceleration of computer-assisted instruction practices, since the 1980s, has made individual and group instruction processes more effective. These practices were initiated to ensure permanent learning and maintain student interest in the lesson (Demircioglu and Geban, 1996). Yet another benefit of computers entering the field of education is that it makes the students more active (Çömek and Bayram, 2004).

The rapid changes occurring in information and communication technologies have also altered the traditional classroom environment and instructional methods. Projectors, Internet linked computers in classrooms, flash disks, mobile phones, digital cameras and video recorders affect many aspects of education ranging from student projects to lesson presentations. Another novelty of the last 20 years has been the interactive whiteboard which consist of a connection between a computer, a projector and a touch screen electronic whiteboard. Owing to their amazing characteristics, interactive whiteboards are also known as "smart boards".

1.1. Interactive Whiteboards (Smart Boards)

Today, many different forms of technology have entered the classroom. Starting from the mid-1990s, electronic interactive whiteboards are a good example of new technologies used in today's classrooms (Beeland, 2001). These whiteboards based on computer technologies seem to be replacing traditional black or white boards, which were once considered indispensable. Interactive whiteboards operate on the connection between a computer, a projector and a touch screen electronic whiteboard. At the heart of the interactive whiteboard lies a touch screen smart board (Klammer et al., 2001) which students can use the touch screen whiteboard to experiment, solve, write and erase applications such as visual experiments, visuals, animations and graphics. Electronic microscopes, multimedia materials, videos, data tables, CD ROM, or the Internet may be used depending on the software programs used by these whiteboards (Miller, Glower and Averis, 2005).

The increasing quality of hardware and software quality resulting from the recent production of interactive whiteboards by many different companies has attracted the interest of governments. Education ministries in many countries are now encouraging the use of interactive whiteboards in classroom. In Turkey too, the Ministry of Education has started a campaign to equip certain schools with interactive whiteboards and to train teachers how to use them. Computer literate teachers have been observed to have the ability to use this technology. Interactive whiteboards have given teachers the opportunity to utilize many new teaching and learning activities in the classroom some of which are summarized in the Table 1 (Beauchamp and Perkinson, 2005):

Table 1: Innovations introduced by interactive whiteboards to the learning and teaching environment

Capturing	Copying and pasting from other software is possible. Other programs may be run on the interactive whiteboard.
Emphasizing	Different patterns of emphasis can be used for a word or group of words (color, movement etc.). In addition, the distractive part of the screen has a hideaway feature.
Storing	All writing and visuals on the whiteboard can be saved, re-used

	in other classes or used in future lesson planning, and shared with students.
Annotating notes	A special pen can be used to add explanatory notes, revise them, or to make hyperlinks to other features such as arrows or lines.
Games	Education through games using "drag and match" or "rearrange jumbled objects or text" is possible and such games may also be prepared by the teacher.
Linking	Links to other pages are possible; Word, Power Point and Excel files can be used; visuals such as detailed concept maps can also be developed and used; Internet connectivity is possible.

As in other computer technologies, the software is the key element in the effective use of interactive whiteboards. New programs for interactive whiteboard include virtual experiments, animations and games prepared for different courses, and teachers can experiment with these applications. Virtual experiments, games and animations prepared with Macromedia Flash 8 are compatible with these programs.

Becta (2003) (British Educational Communications and Technology Agency) have listed the advantages of interactive whiteboards for students as; enhanced motivation, improved participation and cooperation, more attractive presentations, ease of use for younger children since there is no requirement for a keyboard, easier handling of complex concepts with the help of clearer, more effective and dynamic presentations, and the appeal to students with different learning styles. Wall, Higgins and Smith (2005) state that interactive whiteboards are effective tools for initiating and facilitating the learning process and ensuring student participation. Improving information and communication technology skills is another benefit mentioned in the literature (Cuthell, 2003). In a literature survey, Smith, Higgins, Wall and Miller (2005) summarized the benefits of interactive whiteboards as flexibility and multiple facets, effectiveness in multimedia use, support for the lesson plan, diversity of resources, development of information and communication technology skills, and more interaction and student participation in classes. A study conducted in 172 classrooms in 97 primary schools across England between 2004 and 2006 yielded both qualitative and quantitative data. The results revealed that students from classes with interactive whiteboards were 5 months ahead of their peers in mathematics, 7.5 months in science, and 2.5 months in literacy. The conclusions included the fact that interactive whiteboards were particularly useful in teaching of abstract, difficult and complex topics.

Wall et al. (2005) aimed to gather the opinions of primary school pupils about interactive whiteboards, and identify the effects of these tools on teaching and learning. The students listed benefits such as; easier comprehension, higher concentration, improved student participation, more effective presentation of information, use of games, aiding memory, and facilitating and provoking thought. They also added that interactive whiteboards had more positive effects in mathematics and science classes when compared to the English class. They attributed this situation to deficiencies of the software programs used in the latter.

There are other studies also outline the limitations of using interactive whiteboards. For instance, Smith, Hardman and Higgins (2006) observed classes that did and did not use interactive whiteboards for 2 years, and concluded that topics were dealt with more quickly in classes with interactive whiteboards and that less time was allocated to group work in these classes. Further, the fact that less time was spent on quality communication and discussions was viewed as a negative aspect. Their general conclusion at the end of the study was that interactive whiteboards are a useful tool for presentation but not sufficient to realize radical changes in traditional classroom instruction on its own. In addition, student enthusiasm in using interactive whiteboards diminished in the second year. Beauchamp and Perkinson (2005) stated that when the teacher had used all interactive whiteboard related applications, the “wow” factor was eliminated and student interest decreased. Other limitations of interactive whiteboards included technical difficulties, software problems and high costs (Wall et al., 2005).

It is mentioned in many sources that classes using interactive whiteboards by making use of games, results in lessons that are more enjoyable, and make students more willing, excited and enthusiastic (Hall and Higgins, 2005; Beauchamp and Perkinson, 2005; Smith et al., 2006; Beeland, 2001). However, there are also findings that this initial enthusiasm decreases over time (Smith et al., 2006; Beauchamp and Perkinson, 2005). The rapid development of computer related technologies and their profound effects on the teaching and learning process require teachers to make use of these technologies. Beauchamp and Perkinson (2005) report that teachers should see the interactive whiteboard as a tool for using technology in the classroom and for developing new teaching and learning activities. Interactive whiteboards are necessary in the teaching of certain subjects, owing to their ability to keep the attention of students who are already familiar with computer technologies, to make lessons fun, to use multimedia, to make abstract issues more concrete, to enable physical interaction, and to develop information-communication technologies. One subject where interactive whiteboards can be used effectively is the presentation of electricity and electromagnetism, in which animations, virtual experiments and visuals can supplement laboratory studies. Therefore, the aim of this study was to identify the effects of the use of an interactive whiteboard use on the academic achievement of university students.

1.2. Science and Technology Laboratory

The laboratory method frequently used in the natural sciences facilitates student learning of subjects via techniques such as observing, experimenting, doing and showing individually or in groups in a laboratory environment. Previous studies have shown that the most effective and permanent instruction in science education occurs with the use of the laboratory method (Ergün and Özdas, 1997; Gürdal, 1997; Güven and Gürdal, 2002).

Even though the significance of the laboratory method has been well documented, it is not a preferred method in schools perhaps due to a lack of experimental equipment or, if this is not the case, due to the concern that there will not be sufficient time to cover all the curriculum through experiments. Therefore, it is used very rarely, if at all (Kayatürk, Geban and Önal, 1995; Güzel, 2000; Çallica, Erol, Sezgin and Kavcar, 2001; Üce, Özkaya and Sahin, 2001). However, the only way of enriching science classes or science laboratory experiments with visuals is not only limited to experimenting or showing. The results of educational research around the world has shown that the computer is also an ideal tool to realize this.

With the multiple use of educational technologies in science classes, student interest and curiosity in the natural sciences increases and many start to display positive attitudes towards discovery (Akpinar, Aktamis, and Ergin, 2005). Previous studies have also shown that computer assisted instruction positively affects student attitudes towards science (Reed, 1986; Yenice, Sümer, Oktaylar and Erbil, 2003; Çepni, Tas and Köse, 2006; Tas, Köse and Çepni, 2006). In certain studies conducted in and outside Turkey, computer use was found to increase student achievement (Browning and Lehmen, 1988; Ayas, Köse and Tas, 2002; Yenice, 2003; Baser, 2006; Köse, Gezer, Bilen and Gencer, 2007; Kara and Yesilyurt, 2007; Park, Khan and Petrina, 2008; Pektas, Çelik, Katranci and Köse, 2009).

One of the most prominent advantages of computers is the provision of simultaneous simulations of the topic at hand with the help of various programs. This is epitomized in educational software programs which are generally more effective in making abstract concepts more tangible and in teaching topics where the occurrence of misconceptions is possible. One of the topics that are hard to conceptualize and has a potential for misconceptions is electricity. According to Shipstone (1998), adults agree that electricity is a difficult and hard-to-understand topic, similar to other topics in physics such as mechanics.

Previous studies have also revealed that students face problems in understand and there is a risk of misconceptions, and they have difficulty in analyzing abstract issues in the topic of electricity (Shepardson and Moje, 1994; Chambers and Andre, 1997; Sencar, Yilmaz and Eryilmaz, 2001; Sencar and Eryilmaz, 2004; Yildirim, Yalçin, Sensoy and Akçay, 2008).

In this study the interactive whiteboard simulations and virtual experiments which require student participation were developed using electronic whiteboard software and other programs. The main aim was to structure in students' minds the electricity-related phenomena that cannot be demonstrated with the laboratory method; facilitate the understanding of concepts and relationships between these phenomena; and conceptualize topics. The impact of the laboratory method may be increased using the interactive whiteboard for interactive simulations and virtual experiments related to the electric motor, induction current and electric bell. The aim of this study was to determine the effects of interactive whiteboard use on university students' academic achievement in terms of the topic of electricity in the science and technology laboratory class.

2. Method

The study used the pretest/posttest control group experimental design. In this model, the subjects are measured with respect to the dependent variable both before and after the experimental study. The subjects are divided into two groups, experimental and control groups,. The independent variable of this study was the interactive whiteboard use, the effects of which on learning were examined. The experimental group in this study was subjected to the combined use of an interactive whiteboard with educational software developed with Macromedia 8 flash program and the laboratory method. The control group, on the other hand, was allowed to experiment only with the laboratory method. The laboratory method administered to both groups included activities such as experiment, observation and control. Students in both groups learned about the subject and experiments in 8 hours. The dependent variable of the study, academic achievement, was measured in both groups of students with a pretest and posttest. In addition, in order to obtain the views of experimental group students after the experiment, the students were given a semi-structured interview form with four (3) questions as given in section 2.3

Table 2 presents the experimental groups and study design.

Table 2: Experimental Groups and Study Design

Groups	Pretest	Method	Posttest	Interview	N
Experimental Group	1st application	Interactive whiteboard and laboratory method used together.	2nd application	3rd application as a student were asked	17
Control Group	1st application	Only laboratory method.	2nd application	-	16
Total					33

2.1. Study Group

The study group consisted of 33 2nd year students from Kirikkale University, Department of Science Education, Faculty of Education. The experimental and control groups were set up according to the last digit of student registration number. The distribution of male and female students in the groups was homogeneous.

2.2. Academic Achievement Test

Two equivalent forms were prepared for pretest and posttest. Each of the tests contained 20 questions. The targets of the topic of electromagnetism were reviewed for preparation of questions to be included in tests. Questions were prepared taking into account the grade of the targets in Bloom's taxonomy of cognitive domain. In addition, a literature review was performed. The topic/ target table was created in relation to the distribution of the questions in tests according to topics.

2.3. Interview

First, a form including interview questions prepared in accordance with objectives was created. The interview was administered to eight students on a voluntary basis and recorded.

The interview form contained the following questions;

What are. your opinions about the intelligibility of interactive board activities and their effects on students?
What do think are the advantages of interactive board applications in the instructional environment?
What is the greatest impact (feature) of interactive board applications that has impressed you and how would you describe this impact?

2.4. Interactive Whiteboard Use

Interactive simulations are now extensively used in physics and chemistry education (Wieman, Adams, Loeblein and Perkins, 2009). In this study, the researchers prepared a model on the computer for electromagnetism education, which showed the electric motor, electric bell and generation of the induction current using Macromedia 8 flash and the students were asked to apply on the interactive whiteboard (smart whiteboard).

The targets of the topic, abstract concepts and laboratory experiments were taken into account while preparing the interactive simulations.

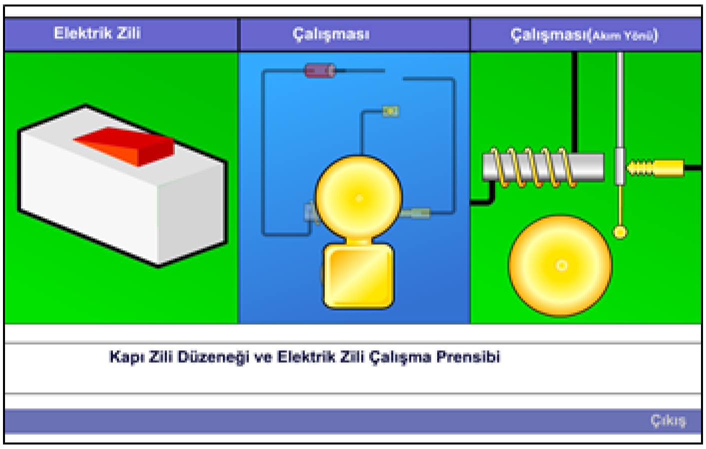
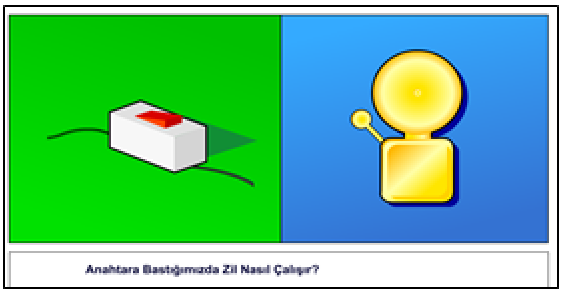
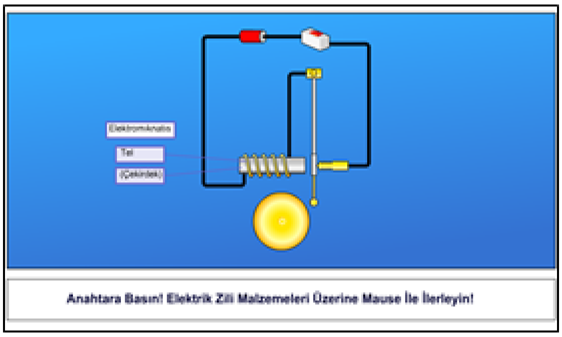


Figure 1. *Educational software prepared by using Macromedia 8 flash program (the bell model)*



2.4.1. Electric Bell Button: is the aim here is that a doorbell model emerges in the mind of the student that clicks on the button displayed on the interactive whiteboard. When the student pushes the button, the bell prepared with the flash program rings.



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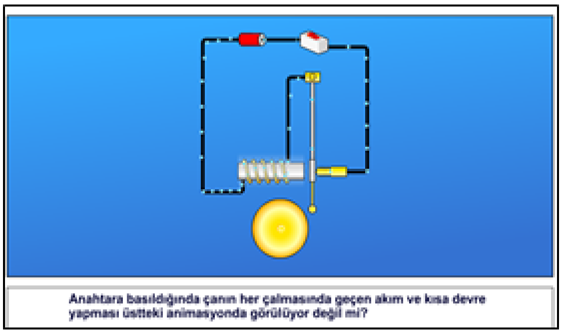
2.4.2. Operation Button: The aim is that the student that clicks on the button on the interactive whiteboard sees the operation of the bell and the elements in its mechanism, and has some understanding about the action.



2.4.3. Operation (Direction of Current) Button: This is the most important button of the software. The student will see the direction of the current, which is usually stated in abstract terms and generally confuses students; s/he will understand the working principle of the bell; and s/he will be able to recognize the short circuit, which makes the bell ring, and comment on this event.

2.4.4. Exit Button: The student will use the button to quit the program when s/he realizes that s/he has understood the topic of bells.

In interactive smart whiteboard applications, a simple white board can be easily transformed into a touch screen smart whiteboard with the installation of a device. The lecturer has the opportunity to mark required parts and explain them in this environment. Any application that can be used on a computer can also be used on a smart whiteboard. The interactive whiteboard used in the study is one that allows students to use the educational software individually. Prior to the study, the experimental group the researchers explained the interactive whiteboard applications for 2 class hours, and each student practiced various simulations and thus learned how to use the interactive whiteboard.

2.5. Data Analysis

The SPSS package program was used in the analysis of the data. In the present study, an interactive model was presented to an experimental group and a control group was applied. With this technique, the experimental and control group students' pretest and posttest total achievement scores before and after the experiment can be compared, and the significance of the difference between experimental and control students' achievement scores from the beginning to the end of the experiment can be assessed (Büyüköztürk, 2004). In data analysis, mean, standard deviation and t–tests were used. An independent groups t-test was used to test the difference between pretest and posttest means of experimental and control group.

3. Findings

In this section the data from the experiment is analyzed and interpreted. The academic achievement pretest mean scores and standard deviation values of the three groups are given in Table 3.

Table 3: Pretest Mean Scores and Standard Deviation Values of Groups

	Groups	N	$\overline{X}$	S
PRETEST	Control	16	35.63	9.98
	Experimental	17	36.47	10.72

As shown in Table 3, the experimental group of students' achievement test mean score before the experiment was $\overline{X}$=36.47. The same value for control group students was $\overline{X}$=35.63. These values show that the achievement levels of the two groups were similar at the beginning of the study. The difference between their mean scores was ($\overline{X}$control - $\overline{X}$experimental)= -0.74. The results of the independent t-test conducted to determine the significance of the difference between mean scores of the groups are presented in Table 4.

Table 4: Independent T-Test Results of Pretest Mean Scores

Groups	N	$\overline{X}$	S	t	DF	P
Control	16	35.63	9.98	-0.169	31	0.816
Experimental	17	36.47	10.72			

According to the results of the t-test shown in Table 4, no significant difference exists between pretest mean scores of groups (P>0.05), thus suggesting that the initial achievement levels of groups were similar. In Table 5, the analyses of the posttest mean scores of groups after the experiment are presented

Table 5: Posttest Mean Scores and Standard Deviation Values of Groups

	Groups	N	$\overline{X}$	S
POSTTEST	Control	16	65.31	16.38
	Experimental	17	70.88	14.39

As shown in Table 5, the post-experiment mean achievement score of experimental group students was $\overline{X}$=70.88, while that of control group students was $\overline{X}$=65.31. This shows a difference between the posttest scores of control and experimental groups at the end of the study. The difference between the mean scores of the groups was ($\overline{X}$ control - $\overline{X}$ experimental)= -5.57. Table 5 shows the achievement percentages of the groups before and after the study. The lower standard deviation values in the experimental group may be due to the effect of interactive whiteboards in increasing homogeneity. Table 6 shows the results of the independent t-test conducted to determine the significance of the difference between mean scores and achievement percentages of the groups.

Table 6: Independent T-Test Results of Posttest Mean Scores

Groups	N	$\overline{X}$	S	t	DF	P
Control	16	65.31	16.38	-1.114	31	0.307
Experimental	17	70.88	14.39			

In Table 6 it can be seen that there is no meaningful difference among posttest mean scores of groups (P>0.05). It was found that the electricity test achievement scores of experimental and control group students did not significantly differ from the beginning to the end of the study, showing that being in different groups and measurement at different times did not significantly affect achievement levels. These findings reveal that the use of the interactive whiteboard did not significantly increase students' academic achievement in the topic of electricity.
Below are the views of some experimental group students.

1. What is your opinion about the intelligibility of interactive board activities and their effects on students?

Female student (1): I think they are appropriate in classes because of their visual elements. I am of the opinion that they increase students' motivation in the classes.
Female student (2): The interactive board is an enjoyable and educational practice that is in accordance with the constructive approach principles of "learning by doing" and "active student participation".
Male student (1): The experiments conducted with the interactive board applications are more meaningful and easy to run than normal experiments. Interactive board

applications are also noteworthy because they are nontraditional.
Female student (3): They reduce the time wasted. They have an important place in schools that lack experimental equipment. They facilitate learning provide permanent learning and encourage student participation in lessons

2. What are the advantages of interactive board applications in the instructional environment?

Female student (4): They ensure quick learning. They teach students how to use technological tools. They also teach better adaptation to modern life.
Male student (5): They can easily be applied to experiments. They make even the least distinct points easily seen.
Female student (3): They ensure active involvement of all students in the class. As they are short applications, I think that classroom management and ensuring teacher's authority will be easier in these applications in comparison to laboratories.

3. What is the greatest impact (feature) of interactive board applications that impressed you and how would you describe this impact?

Male student (8): For me, the touch screen feature during laboratory experiments is fun and impressive.
Female student (1): They break students' dependence on textbooks. Most importantly, they can be used in schools without laboratories. They allow us to access experiments at any time.
Male student (3): The visual elements make classes more fun, enjoyable and exciting. When a student uses the interactive board, s/he feels like part of the board.

4. Results and Discussion

This study focused on the effects of interactive whiteboard use on university students' academic achievement in the topic of electricity in the science and technology laboratory class. No significant difference was found between academic achievement scores of experimental students who were engaged in both interactive whiteboards and laboratory practices and those of control students, who only underwent laboratory practices. Despite the lack of a significant difference, the experimental group students had higher academic achievement scores. At the same time, the partially lower posttest standard deviation values in the experimental group may result from the role of interactive whiteboard in increasing homogeneity in the classroom.

Even though interactive whiteboard use might not increase students' academic achievement significantly, it was seen that it encouraged student participation in the lesson, created a more exciting and enthusiastic atmosphere, and led to more enjoyable lessons. These findings overlap with the benefits mentioned by other studies (Becta, 2003; Wall et al, 2005; Cuthell, 2003; Smith et al, 2005; Camnalbur and Özdener, 2008). In addition, many students in the experimental group stated that interactive simulations and virtual experiments involved situations that they did not normally encounter in real experiments and this enabled them to visualize the topic. Similar findings have been reached by other researchers, (Perkins et al., 2004; Wieman and Perkins 2006; Perkins et al., 2006; McKagan, Handley, Perkins and Wieman, 2009).

From a general perspective, the results of the study are similar to those encountered in the literature. It was also found during the study that lessons conducted with interactive whiteboards were more fun, had more on-task time and greater participation. The most significant evidence for the academic improvement resulting from interactive whiteboard use was a comprehensive study conducted by Becta (2003). In this study, the term 'improvement' was used instead of reference to 'increasing academic achievement'.

Based on these results, it can be claimed that an interactive whiteboard should not be seen as a tool that increases academic achievement, but one that brings information and communication technologies to the classroom and leads to new teaching and learning activities (Beauchamp and Perkinson, 2005).

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