academicJournals

Vol. 11(7), pp. 459-465, 10 April, 2016
DOI: 10.5897/ERR2016.2691
Article Number: A440DDD57827
ISSN 1990-3839

http://www.academicjournals.org/ERR

Educational Research and Reviews

Full Length Research Paper

High school students' attitudes towards smart board use in Biology classes

İ. Ümit YAPICI[1] and Ferit KARAKOYUN[2]

[1]Department of Biology Education, Dicle University Faculty of Education, Diyarbakır, Turkey
[2]Department of Computer and Instructional Technology Education, Dicle University Faculty of Education,Diyarbakır, Turkey.

Received 09 February, 2016; Accepted 9 March, 2016

The present study aimed at determining high school students' attitudes towards smart board use in biology classes. The study was carried out using the survey model. The study group was made up of 200 high school students. As the data collection tool, the "Student Attitude Scale for Smart Board Use" developed by Elaziz was used. The reliability coefficient of the scale was 0.78, and it was calculated as 0.87 in the present study. The results of data analyses revealed that the students demonstrated positive attitudes in general. Consequently, it could be stated that smart board use in biology classes allows understanding of subjects more easily and rapidly, avoiding time consumption and increasing students' motivation and interest via visual elements. The students' attitude scores did not differ statistically with respect to the variables of "gender" and "smart board use time".

Key words: Biology, smart board, attitude.

INTRODUCTION

Today, ways of accessing information have changed and varied in line with technological developments. This rapid change has not only influenced all areas of life but affected and transformed the education system as well. Adaptation of our education system to the changes will be possible if it meets the expectations and fits the developing and changing technology. Traditional class environments are being replaced gradually by new learning environments. In other words, instead of the chalk and black board used previously, today white boards and smart boards are in use (Elmas et al., 2012; Tarman, 2011).

Among the countries leading the use of smart board is England. Between 2003 and 2005, smart boards were used in classrooms in England thanks to a budget of 50 million pounds. A study carried out in 2007 revealed that the smart board system was used in all the elementary schools and 98% of the secondary schools in England (Lai, 2010). This change also attracted attention in other countries in Europe. In our country, "FATIH Project (Movement of Enhancing Opportunities and Improving Technology)" could be given as an example. Within the scope of this project, the Ministry of National Education tries to equip all classrooms with a smart board, projector, wired Internet connection and a tablet computer for all students and teachers and aims at accomplishing this in

*Corresponding author. E-mail: iuyapici@gmail.com.

a five-year period oftime. With this project, it will eventually be possible for a total of 40 thousands of schools and 620 thousands of classrooms to access information technologies, and the necessary trainings for effective use of these technologies will be given (Ministry of National Education, 2011).

Although there are many types of interactive boards (smart boards) with different hardware features, they can, in their nature, be defined as tools that present the educational content with its multimedia features to students thanks to the computer, software and a project. The concept of interaction found in its name refers to the physical activity of students using the hardware as well as to cooperative learning opportunities (Higgins et al., 2007).

The fact that the board screen is touch-sensitive with its interactive features allows the teacher and students to interact with the screen, to make changes on anything seen on the screen and to save them. Audios, videos, animations, colors, images and zooming make lessons more visual and entertaining. Such capabilities of the smart board as instantly recognizing a mistake or common misconceptions and undoing to correct them could possibly be regarded as one of the most important advantages of the smart board. A smart board is just like a moderator for the interaction between the teacher and students when it is used in a long period of time (Lewin et al., 2008).

The basic benefits of the smart board include providing more varied, creative and attractive instructional materials, increasing the pleasure and motivation, and facilitating students' participation in class by having them interact with the activities on the smart board (Becta, 2003; Elaziz, 2008). In addition, it is also reported that the smart board increases students' success (López, 2010) and permanent learning (Smith et al., 2005). Besides all these benefits of the smart board, it also brings about some disadvantages. Especially technical problems, teachers' failure to use the smart board, students' lack of necessary knowledge, lack of the necessary software-hardware and other similar problems are among common problems experienced in relation to smart board use (Elaziz, 2008; Erduran and Tataroğlu, 2009¸ Glover et al., 2007; Türel, 2012).

If the smart board is to be used effectively in teaching and learning, it should be used with all its potential. The teacher should be able to adapt this tool to his or her own teaching approach and to learn how to use the opportunities provided by the smart board for learning. New tools allow creating a variety of new activities, but these activities are created by users as they improve their related skills not by the tools themselves (Lewin et al., 2008).

The fact that the concepts in biology education are abstract and complex makes it difficult for students to learn certain subjects and to memorize them without understanding them (Kılıç and Sağlam, 2004). In order to overcome this problem, it is fairly important to use instructional technologies in biology lessons. Well-prepared pictures, three-dimensional models, animations and interactive environments all help understand the target information easily (Çömlekçioğlu and Bayraktaroğlu, 2001). Schut (2007), in her study, reported that the use of the smart board increases the students' understanding of biology. Therefore, smart board use could be said to be quite important for effective teaching of biology.

Review of the related literature revealed that there is no research conducted to examine students' attitudes towards smart board use in biology lessons. It is thought that the present study will contribute to the related literature in the field. In this respect, the purpose of this study was to determine students' attitudes towards smart board use in high school biology lessons. For this purpose, the following research questions were directed in the study:

1. What are high school students' attitudes towards smart board use in biology lessons?
2. Do high school students' attitudes towards smart board use in biology lessons differ with respect to their gender?
3. Do high school students' attitudes towards smart board use in biology lessons differ with respect to the smart board use time?

METHODS

Research model

In the study, the survey model was used. The survey model aims at describing a past or present situation as it was or as it is. Individuals, objects or events that constitute the research subject are defined as they are in their own conditions and situations (Karasar, 2002).

Study group

The study was carried out with 200 randomly-selected 10^{th}-grade students attending a high school used as a pilot school within the scope of FATIH Project in the city of Diyarbakır in Turkey in 2014 academic year. The school was selected by purposive sampling. Also the students were selected on voluntary basis. Due to the greater number of the biology classes, 10^{th} grades were preferred. Of all these students, 115 of them were females (58%), and 85 of them were males (42%). In addition, among the students, 127 of them reported that they used the smart board in class for one or two class hours a week (63%) and 73 of them said they used it in class for three or four class hours a week (37%).

Data collection

In the study, the "Student Attitude Scale for Smart Board Use" developed by Elaziz (2008) was used. The scale was made up of 21 five-point Likert-type items, seven of which included negative statements. The scale was administered by paper. In addition, there were six sub-dimensions in the scale: learning (D1), technical (D2), affective (D3), motivation (D4), time management-organization (D5) and difference from the black board (D6). The Cronbach Alpha

Table 1. Descriptive statistics for the whole scale.

N	Min	Max	Mean	SD
200	1.42	5.00	3.60	0.64

Table 2. Findings regarding the dimension of learning.

Statements	Mean	Med.	SD
1. I learn more when the teacher uses the smart board.	3.9	4	1.21
2. It is easier to understand the subject when the teacher uses the smart board.	3.9	4	1.16
3. What the teacher writes and draws is more comprehensible thanks to the smart board.	3.9	4	1.22
4. Audio-visual materials presented with the smart board make it easier for me to understand the subject.	4.2	4	1.08
5. The smart board provides me with the opportunity to learn a subject from different sources.	3.7	4	1.19
14. The smart board makes learning more entertaining and interesting.	3.9	4	1.17

5.00-4.20 I completely agree, 4.19-3.40 I agree, 3.39-2.60 I am neutral, 2.59-1.80 I disagree, 1.79-1.00 I completely disagree.

Table 3. Findings regarding the technical dimension.

Statements	Mean	Med.	SD
6. Deficiencies in videos or images and failure to hinder the sun light sometimes prevent me from seeing those presented on the smart board.	2.4	2	1.30
7. The smart board frequently breaks down, and its repairment or adjustment results in waste of time.	3.4	4	1.28

5.00-4.20 I Completely agree, 4.19-3.40 I agree, 3.39-2.60 I am neutral, 2.59-1.80 I disagree, 1.79-1.00 I completely disagree

reliability coefficient of the scale was 0.78, and it was calculated as 0.87 for the present study. As for the sub-dimensions, the coefficients were calculated as 0.87, 0.70, 0.74, 0.87, 0.72, and 0.77, respectively. The results of the Kolmogorov-Smirnov Z test analysis showed that the data comply with the parametric tests (Z= ,646; p= ,797). For the analysis of the research data, SPSS 16.0 was used, and the frequencies, percentages and t-test results are presented.

FINDINGS

Table 1 demonstrates the descriptive statistics regarding the whole scale. When Table 1 is examined, it is seen that the overall mean score for the scale was found to be 3.60 and that the students generally had positive attitudes. Table 2 presents the findings regarding the *learning* dimension of the scale.

According to Table 2, the students agreed with all the statements in the *learning* dimension of the scale. The highest mean score (4,2), at the level of "I completely agree", belonged to the statement of "Audio-visual materials presented with the smart board make it easier for me to understand the subject". Table 3 presents the findings regarding the *technical* dimension of the scale.

When Table 3 is examined, it is seen regarding the *technical* dimension of the scale that the students did not agree with the statement of "Deficiencies in videos or images and failure to hinder the sun light sometimes prevent me from seeing those presented on the smart board" (2.4) but agreed with the statement of "The smart board frequently breaks down, and its repairment or adjustment results in waste of time".

Table 4 presents the findings regarding the affective dimension of the scale. Table 4 demonstrates that the students were neutral regarding the *affective* dimension in relation to the statement of "I like using the smart board in class" (3.1) and that they agreed with all the other statements. Table 5 presents the findings regarding the *motivation* dimension of the scale.

When Table 5 is examined, it is seen that the students agreed with all the statements regarding the *motivation* dimension of the scale and that the highest mean score belonged to the statement of "I can concentrate more on lessons when the smart board is used" (3.7).

Table 6 presents the findings regarding the scale dimension of time management-organization.

When Table 6 is examined, it is seen that the students agreed with the negative statement of "when my teacher uses the smart board, I cannot keep up with the lesson as the pace of the lesson is much faster" (3.7) as well as with all the other positive statements. The highest mean score was found to belong to the statement of "Use of the

Table 4. Findings regarding the affective dimension.

Statements	Mean	Med.	SD
8. I like using the smart board in class.	3.1	3	1.38
9. It is difficult for me to use the smart board.	4.1	4	1.21
10. I prefer the classes in which the smart board is used.	3.4	4	1.21
11. It bothers me if my homework or assignment is presented to whole class with the smart board.	3.7	4	1.28

5.00-4.20 I completely agree, 4.19-3.40 I agree, 3.39-2.60 I am neutral, 2.59-1.80 I disagree, 1.79-1.00 I completely disagree.

Table 5. Findings regarding the *motivation* dimension.

Statements	Mean	Med.	SD
12. I can concentrate more on lessons when the smart board is used.	3.7	4	1.15
13. I participate more in lessons when the teacher uses the smart board.	3.5	4	1.12
15. I can draw my attention to lessons more easily and stay interested in lessons longer when the smart board is used.	3.5	4	1.10
16. Use of the smart board contributes to my motivation in lessons.	3.5	4	1.20

5.00-4.20 I completely agree, 4.19-3.40 I agree, 3.39-2.60 I am neutral, 2.59-1.80 I disagree, 1.79-1.00 I completely disagree

Table 6. Findings regarding the scale dimension of *time management-organization*.

Statements	Mean	Med.	SD
17. When my teacher uses the smart board, I cannot keep up with the lesson as the pace of the lesson is much faster.	3.7	4	1.25
18. Use of the smart board makes lessons more planned and organized.	3.7	4	1.09
19. Use of the smart board saves time, and the teacher can teach lessons faster.	3.9	4	1.15

5.00-4.20 I completely agree, 4.19-3.40 I agree, 3.39-2.60 I am neutral, 2.59-1.80 I disagree, 1.79-1.00 I completely disagree.

smart board saves time, and the teacher can teach lessons faster" (3.9).

Table 7 presents the findings regarding the dimension of difference from the black board. When Table 7 is examined, it is seen the students did not agree with the negative statements regarding the dimension of *difference from the black board*.

Tables 8 and 9 present the results of the independent groups t-test conducted to determine whether the students' scores differed depending on the variable of gender.

When Tables 8 and 9 are examined, it is seen that the students' attitude scores did not differ significantly in terms of gender for the whole scale and the sub-dimensions ($p > .05$).

The results of independent groups t-test conducted to reveal whether there was a significant difference between the students' attitude scores with respect to smart board use time can be seen in Tables 10 and 11.

When Tables 10 and 11 are examined, it is seen that the students' attitude scores did not differ significantly with respect to smart board use time for the whole scale and the sub-dimensions ($p > 0.05$).

DISCUSSION AND CONCLUSION

The results of the present study carried out to determine high school students' attitudes towards smart board use in biology lessons revealed that the students generally had positive attitudes ($\overline{X}$ = 3.6). The findings regarding the *learning* dimension of the scale demonstrated that thanks to the positive effects of audio-visual elements, the smart board use in biology lessons made important contributions to the learning process such as helping understand subjects more easily, making the teacher's writing and drawing more comprehensible, providing the opportunity to learn the subjects from different sources and making learning more entertaining. In related literature, there are a number of studies reporting similar findings. According to the results of a study on smart boards published by University of Newcastle, students learn better with the help of lessons involving a multimedia content (Higgins et al., 2007). In another study conducted by Erduran and Tataroğlu (2009) to investigate smart board use in the courses of science and mathematics, it was found that the smart board had positive influence on the learning environment and

Table 7. Findings regarding the dimension of *difference from the black board.*

Statements	Mean	Med.	SD
20. Our teachers apply the same methods and teaching styles when they use the smart board and when they teach with the black board.	2.4	3	1.39
21. To me, there is not much difference between the smart board and the black board.	2.5	4	1.39

5.00-4.20 I completely agree, 4.19-3.40 I agree, 3.39-2.60 I am neutral, 2.59-1.80 I disagree, 1.79-1.00 I completely disagree.

Table 8. Independent groups t-test results regarding the attitude scores with respect to gender.

Group	N	$\overline{X}$	SD	dF	t	p
Male	85	3.53	0.64	198	1.803	0.073
Female	115	3.69	0.64			

Table 9. Independent groups t-test results for the sub-dimensions regarding the attitude scores with respect to gender.

Dimensions	Group	N	$\overline{X}$	SD	df	t	p
D1	Male	85	4.01	0.86	198	1.369	0.173
	Female	115	3.84	0.94			
D2	Male	85	3.07	1.01	198	2.546	0.072
	Female	115	2.90	1.01			
D3	Male	85	3.64	0.80	198	0.433	0.154
	Female	115	3.47	0.78			
D4	Male	85	3.62	0.93	198	1.032	0.303
	Female	115	3.48	1.05			
D5	Male	85	3.78	0.80	198	0.349	0.727
	Female	115	3.73	0.85			
D6	Male	85	3.48	1.15	198	1.056	0.292
	Female	115	3.30	1.21			

Table 10. Independent groups t-test results for the attitude scores with respect to smart board use time.

Group	n	$\overline{X}$	SD	dF	t	p
1-2 h	127	3.65	0.67	198	1.169	0.244
3-4 h	73	3.54	0.60			

increased students' participation in classes by attracting their attention to lessons. According to Altınçelik (2009), videos, animations and virtual environments provide students quite authentic contexts and make it possible to convey totally real phenomena into class. These environments full of unprocessed information allow students to structure their own knowledge.

The findings regarding the *motivation* dimension of the scale were striking. It was found that smart board use increased the students' motivation, helped them

Table 11. Independent groups t-test results for the sub-dimensions regarding the attitude scores with respect to smart board use time.

Dimensions	Group	N	$\overline{X}$	SD	df	t	p
D1	1-2 h	127	3.90	0.91	198	-0.452	0.652
	3-4 h	73	3.96	0.89			
D2	1-2 h	127	3.03	1.05	198	2.603	0.550
	3-4 h	73	2.95	0.92			
D3	1-2 h	127	3.63	0.82	198	1.818	0.071
	3-4 h	73	3.43	0.73			
D4	1-2 h	127	3.54	1.04	198	-0.141	0.888
	3-4 h	73	3.56	0.91			
D5	1-2 h	127	3.80	0.79	198	0.896	0.372
	3-4 h	73	3.68	0.88			
D6	1-2 h	127	3.25	1.18	198	2.531	0.252
	3-4 h	73	3.13	1.14			

avoid concentration problems and contributed to their participation in lessons. In related literature, the advantage of smart boards claimed to be among the most important ones was that smart board use motivates students more (Smith et al., 2005). In a study carried out with 35 teachers using smart board in the course of science and mathematics, it was reported that smart board use increased students' interest, motivation and participation. Audios, animations, videos and images used in a learning environment make classes more entertaining (Erduran and Tataroğlu, 2009). Similarly, Elaziz (2008) and Lewis (2009), in their research on smart board use, point out that smart boards have positive influence on students and increase their motivation and that teachers find smart board use exciting.

The findings regarding the dimension of *time management-organization* revealed that lessons are taught in a more planned and organized way thanks to the smart board and that it helped save time. According to Gillen et al. (2007), the smart board has more positive influence on the pace and fluency of teaching when compared to other previous technologies. When viewed from the perspective of pedagogical interaction, smart board use provides the teacher with the opportunity to observe their students better and to respond to their questions.

Despite all these advantages of the smart board, it also brings about certain disadvantages in biology lessons. Especially such technical problems as occasional break down of smart boards have negative influence on its time-saving advantages. Although students hold the belief that it helps save time during lessons, they have complaints about such technical problems. Smith and colleagues (2005), in their study, reported that the students mentioning technical difficulties complained about the amount of time wasted while waiting for the turn-on and shut-down of the smart board. Erduran and Tataroğlu (2009) point out that technical problems experienced during lessons distract students' attention and has negative influence on the teacher's willingness to use the smart board.

The findings obtained revealed that apart from technical problems, the students found smart board use difficult and were reluctant to use it. Lewis (2009) claims this situation to be due to lack of competency and experience in smart board use. According to the researcher, teachers' lack of competency and experience in smart board use cause students to find this technology difficult to use.

Besides these disadvantages of smart board use, the students reported that smart boards helped save time and that they, however, experienced difficulty following the lessons especially when the teacher taught fast. According to the results of a study on physics lesson carried out by Olgun (2012), as lessons are taught faster with the smart board when compared to other boards, students are reported to have difficulty structuring the subjects taught. For this reason, it was thought that some students have difficulty understanding the subjects and that they have the necessary time to structure the information as lessons are not taught with other boards as fast as they are with the smart board.

All these findings revealed that the students' attitudes towards smart board use in biology lessons did not differ

significantly with respect to the variables of gender and smart board use time. In one study carried out by Koçak (2013) to examine the relationship between individuals' demographical backgrounds and their attitudes towards the interactive board, it was found that the participants' attitudes did not cause any significant difference in terms of gender. Similarly, other studies conducted by Zengin et al. (2011) (on science and technology course), Muhanna and Nejem (2013) and Çelik and Gündüz (2015) (on mathematics course) demonstrated that the participants' attitudes towards the smart board did not differ depending on their gender.

Consequently, the biology course could be said to be the one most suitable for smart board use in terms of its fields and scope. Therefore, it is quite important to maintain students' positive attitudes and to overcome the disadvantages of smart board use. In order to achieve this, teachers have important duties. Both at the level of university education and with the help of in-service trainings, teachers' competencies in smart board use should be developed. With the help of the attractive features of the smart board, students should be encouraged to use it. For this purpose, the techniques of drag-and-drop and other entertaining applications can be used. Students should be given time necessary to internalize the subjects. Otherwise, such advantages as fast flow of teaching and time saving will become unimportant. The precautions necessary to minimize the technical problems should be taken (for instance, carrying out maintenance of the smart board and updating the related software). By conducting qualitative studies on smart board use in biology lessons, more detailed results could be obtained. Besides equipping classrooms with smart board systems thanks to FATIH Project, table computes have been distributed to students. On the other hand, there is a need for new studies on the adaptation of tablet computers to smart boards as well as on mobile applications that can be used on tablet computers. Also, the study could be carried out with more participants to increase the generalizability of the results.

Conflict of Interests

The authors have not declared any conflict of interests.

REFERENCES

Altınçelik B (2009). İlköğretim düzeyinde öğrenmede kalıcılığı ve motivasyonu sağlaması yönünden akıllı tahtaya ilişkin öğretmen görüşleri. Yüksek Lisans Tezi, Sosyal Bilimler Enstitüsü, Sakarya Üniversitesi, Türkiye.

BECTA (2003). What the research says about ICT and motivation. Retrieved 15 September 2015 from www.becta.org.uk.

Çelik HC, Gündüz S (2015). Öğrencilerin matematik dersinde akıllı tahta kullanımına yönelik tutumların çeşitli değişkenler açısından incelenmesi. Dicle Üniversitesi Ziya Gökalp Eğitim Fakültesi Dergisi, 25:157-174.

Çömlekçioğlu U, Bayraktaroğlu E (2001). Biyoloji ve Bilişim Teknolojileri. Kahramanmaraş Sütçü İmam Üniversitesi Fen ve Mühendislik Dergisi, 4(1).

Elaziz F (2008). Attitudes of students and teachers towards the use of Interactive whiteboards in EFL classrooms. Unpublished MA thesis. Bilkent University. Ankara.

Elmas R, Demirdöğen B, Geban Ö (2011). Preservice chemistry teachers' images about science teaching in their future classrooms. Hacettepe University J. Educ. 40:164-175.

Erduran A, Tataroğlu, B (2009). Eğitimde akıllı tahta kullanımına ilişkin fen ve matematik öğretmen görüşlerinin karşılaştırılması. 9th. International Educational Technology Conference, Ankara.

Gillen J, Kleine SJ, Littleton K, Mercer N, Twiner A (2007). A"learning revolution"? Investigating pedagogic practices around ınteractive whiteboards in British primary classrooms. Learning, Media Technol. 32(3):243-256.

Glover D, Miller D, Averis D, Door V (2007). The evolution of an effective pedagogy for teachers using the interactive whiteboard in mathematics and modern languages: an empirical analysis from the secondary sector. Learning, Media Technol. 32(1):5-20.

Higgins S, Beauchamp G, Miller D (2007). Reviewing the literature on interactive whiteboards. Learning, Media, Technol. 32:213-225.

Karasar N (2002). Bilimsel Araştırma Yöntemi. Ankara: Nobel Yayın Dağıtım.

Kılıç D, Sağlam N (2004). Biyoloji eğitiminde kavram haritalarının öğrenme başarısına ve kalıcılığına etkisi. Hacettepe Üniversitesi Eğitim Fakültesi Dergisi, 27:155-164.

Koçak Ö (2013). Fatih Projesi Kapsamındaki LCD Panel Etkileşimli Tahta Uygulamalarına Yönelik Öğretmen Tutumları (Erzincan İli Örneği). MA thesis, Institute of Educational Sciencs, Atatürk University, Erzurum.

Lai HJ (2010). Secondary school teachers' perceptions of interactive whiteboard training workshops: A case study from Taiwan. Australasian Journal of Educational Technology, 26(4):511-522.

Lewin C, Somekh B, Steadman S (2008). Embedding interactive whiteboards in teaching and learning: the process of change in pedagogic practice. Educ. Infor. Technol. 13:291-303.

Lewis AC (2009). The integration of interactive whiteboards into classrooms at a well-resourced high school in South Africa. Doctoral dissertation, University of Pretoria.

López OS (2010). The digital learning classroom: Improving english language learners' academic success in mathematics and reading using interactive whiteboard technology. Computers Educ. 54(4):901-915.

Ministry of National Education (2011). Milli Eğitim Bakanlığı FATİH Projesi. [FATİH Project by Ministry of National Education].Retrieved from http://fatihprojesi.meb.gov.tr.

Muhanna W, Nejem KM (2013). Attitudes of mathematics teachers toward using smart board in teaching mathematics. Contemporary Issues in Educ. Res. 6(4):373-380.

Olgun H (2012). Fizik dersinde ortaöğretim öğrencilerinin akıllı tahta kullanımı ile ilgili algılarının araştırılması. MA thesis, Marmara University, Institute of Educational Sciences, İstanbul.

Schut C (2007). Student perceptions of interactive whiteboards in a biology classroom. Unpublished MA thesis. Cedarville University, Ohio.

Smith HJ, Higgins S, Wall K, Miller J (2005). Interactive whiteboards: Boon or bandwagon? A critical review of the literature. J. Computer Assisted Learn. 21(2):91-101.

Tarman B (2011). Sosyal bilgiler eğitiminde sosyal bilgiler laboratuvarlarının yeri ve önemi, (Ed. R. Turan, A.M. Sünbül& H. Akdağ). Sosyal Bilgiler Öğretiminde Yeni Yaklaşımlar II, Ankara: Pegem A Yayıncılık.

Türel YK (2012). Teachers' negative attitudes towards ınteractive whiteboard use: Needs and problems. Elementary Educ. Online, 11(2):423-439.

Zengin FK, Kırılmazkaya G, Keçeci G (2011). Akıllı Tahta Kullanımının İlköğretim Öğrencilerinin Fen ve Teknoloji Dersindeki Başarı ve Tutuma Etkisi. 5th International Computer & Instructional Technologies Symposium. Fırat University, Elazığ.