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Abstract

The aim of this study is to examine the effect of smart board use on academic achievement. For this purpose, mixed method where quantitative and qualitative methods are combined is used. In the quantitative phase of the research, 47 experimental studies examining the effect of smart board use on academic achievement, which were accessed by the literature review and conformed to the inclusion criteria determined by the researcher, were analyzed according to random effects model using meta-analysis method. As a result of the analysis, it was found that the effect size of smart board use on academic achievement was positive, large, and significant ($ES_{(d)} = .94$, $p < .05$). The calculated effect size does not differ according to the type of publication, school level, and field of science (course), publication year, sample size and duration of experiment implementation. The data collected in the qualitative phase of the research were analyzed using descriptive and content analysis methods. The following results were obtained under the theme of the positive aspects of smart board use: "it provides permanent learning", "supports visual and auditory learning", "makes topics more concrete". The following results were obtained under the theme of the negative aspects of smart board use: "teachers' inability to use the smart board leads to a waste of time and disrupt the course", "teachers can be overshadowed by the smart board", "smart board makes the student and teacher lazy, and they get used to smart board doing everything". The following results were obtained under the theme of suggestions: "teachers should be trained on smart board use", "different functions should be used besides presentation (video, sound, educational game, animation etc.)", "smart boards should not be used all the time, only when necessary".

Introduction

Rapid changes in information and communication technologies have been effective in education as well as in all other areas of life and have brought about fundamental changes in traditional classroom environments and teaching methods. Parallel to these changes, computers, tablets, projectors, flash disks, mobile phones, digital cameras and video recorders entering the teaching environment affected many aspects of education from student projects to presentation of lectures. Another innovation of the last two decades is the smart board that combines the computer, projector, and touch screen electronic board (Akbaş & Pektaş, 2011).

Smart boards are one of the most popular educational technologies in today's world (De Vita, Verschaffel & Elen, 2018). Smart boards were first used in education in the late 1990s (Beeland, 2002), and quickly began to be used in many countries around the world. They are expected to become even more widespread in the next five years (De Vita et al., 2018). The United Kingdom is one of the leading countries in smart board use. Between 2003 and 2005, the UK made an intensive effort to increase smart board use in schools with a budget of £50 million. In a study conducted in 2007, it was stated that all primary schools and 98% of secondary schools in the UK were using smart boards (Lai, 2010). Other countries have not been indifferent to the interest in smart boards. Today, 60-70% of classrooms in countries such as the Netherlands, Denmark and Australia, 50% of classrooms in the USA, Canada and Spain, and 20-30% of classrooms in other countries, such as Germany, Korea, China, Italy and Israel, have smart boards (Hennessy & London, 2013; cited by Aflalo, Zana & Huri, 2018).

Just like the UK and many other countries, Turkey has shown an intense effort in recent years in order to equip its schools with instructional technologies. Prepared and put into force in 2010 with the cooperation of the Ministry of National Education and the Ministry of Transport, FATİH (Movement for Increasing Opportunities and Technology Improvement) project aimed to equip 570 thousand classrooms in 40 thousand schools with laptops, projection devices, internet, multi-purpose printers and smart boards. In the most recent communication, it was stated that smart boards have been placed in approximately 432 thousand classrooms. The need for smart boards for the remaining schools and classrooms has been identified and it is reported that contact with suppliers continues in this regard (FATİH project, 2018; cited by Soylu & Bozdoğan, 2019).

Smart boards offer great convenience to educators during lessons. The educator can use the board by touching the screen with a pen or a finger. The educator can use the smart board to perform many functions such as to drag, cut and copy items; to take handwritten notes, convert these into text and highlight them; add annotations, notes, drawings and save them for printing and sharing; show animations and videos to all students in the classroom; capture and save screenshots, to retrieve, review and change these if necessary; to use the contents of websites (Balta & Duran, 2015). Smart boards are equipped with their own software. However, they also serve as a digital center that enables teachers and students to integrate the Internet and other hardware resources into the lessons (Mercer, Hennessy & Warwick, 2010). All these functions of smart boards are thought to have a significant effect on the quality of education. Studies in the literature support this notion.

When studies in the literature are reviewed, it is seen that using smart boards in education creates a learning environment rich in visual and auditory aspects, and makes learning materials more concrete (Beeland, 2002; Batdı, 2017; Wall, Higgins & Smith, 2005; Demir, Öztürk & Dökme, 2011), makes lessons and learning fun, increases the interest, motivation and concentration towards the lesson and also contributes positively to the interaction between teacher and student (Akar & Karakaş, 2020; Batdı, 2017; Higgins, Beauchamp & Miller, 2007; Davidovitch & Yavich, 2017; Beauchamp & Kennewell, 2008; Wall, Higgins & Smith, 2005; Bozkuş & Karacabey, 2019; Sünkür, Şanlı & Arabacı; 2011; Torrf & Tirotta, 2009), accelerates learning and saves time (Cogill, 2002; Glover & Miller, 2001), increases the participation of students and provides permanent learning (Akar & Çelik, 2020; Glover, Miller, Averis & Door, 2005; Paragina, Paragina & Jipa, 2010), positively affects academic achievement and performance, attitude towards the course (Akar & Çelik, 2020; Lopez, 2010; Saraç, 2019), provides more learning content (Cogill, 2002), and increases students' ability to use technology (Manny-Ikan, Dagan, Tikochinski & Zorman, 2011).

The effect of smart boards, which have become widespread in education in Turkey, especially with the FATIH project, on the academic achievement of students has attracted and continues to attract the attention of both education authorities and many educators and researchers. In this context, many experimental studies have been conducted to determine whether smart board use (compared with traditional tools) has a positive effect on academic success in teaching various courses and subjects. In these studies, the use of smart boards on students' academic achievement in science (Akbaş & Pektaş, 2011; Öztan, 2012; Özenç & Özmen, 2014; Özçelik, 2015; Sarıkaya, 2015; Sarı & Güven, 2013; Kaynak & Ünal, 2018), mathematics (Batdı, 2017; Akçayır, 2015; Tataroğlu, 2009; Tunaboylu & Demir, 2017; Turan, 2014; Yorgancı & Terzioğlu, 2013), social sciences (Akdemir, 2009; Keser, 2012), visual arts (Akgül, 2013; Yağcı, 2018)), Turkish (Kırbaş, 2018; Tayfa, 2018), English (Şen, 2013), and vocational training (Gürsoy, 2014; Dikmen, 2015) courses has been examined. It is seen that there are enough primary studies on the subject. In the literature review, a number of meta-analysis studies that examined the effect of smart board use on academic achievement were also found (Badtı, 2017; Saraç, 2017; Güzdüz & Kutluca, 2019).

When these studies were analyzed, it was seen that Gündüz and Kutluca (2019) studied the topic in the context of science and mathematics lessons and excluded the other lessons. In this context, the results of 25 studies conducted between 2008 and 2018 in Turkey were synthesized. In the study by Saraç (2017), 29 studies that were conducted between 2008 and 2016 in Turkey were reached and the results of these studies were combined. It is noteworthy that the study by Batdı (2017) is quite extensive. Badtı (2017) carried out this study within a new approach, which he developed and called *multi-complementary approach* (Badtı, 2016). In this approach, the effect of smart board use on academic achievement was analyzed by using multiple methods (meta-analysis, meta-thematic, qualitative and experimental). In the meta-analysis part of the study, Badtı (2017) reached 25 studies conducted in Turkey and other countries between 2000 and 2015. Out of these studies, 18 were carried out in Turkey and 7 were conducted in other countries. In the qualitative phase of his study, Badtı (2017) consulted the opinions of the students on the smart board and interpreted the subject according to their perspective. There is no doubt that, as the use of the smart board in educational institutions increases, the number of studies on this topic also increase every day. Accordingly, the studies vary in terms of the grade level, lesson, location and etc. In this respect, it is important to carry out secondary studies (meta-analytics) in

which the most recent studies on the topic are included. The necessity of addressing these studies with a holistic approach, synthesizing the results and presenting a general conclusion has been a driving force for conducting this study.

In addition to this, it is aimed to support the quantitative data obtained on the effect of smart board use on academic achievement with qualitative results (based on teacher and student opinions), and to reach results that will guide the practitioners. This study is a unique study that differs from other studies in that it contains the most recent studies on the subject in Turkey and includes the opinions of teachers and students in a qualitative phase. In this context, the aim of this study is to examine the effect of smart board use on academic achievement. For this purpose, answers to the following questions were sought.

- ✓ What is the effect size of smart board use on academic achievement?
- ✓ Does the effect size of smart board use on academic achievement differ according to the type of publication, school level, and field of science (course), publication year, sample size and duration of experiment implementation?
- ✓ According to the opinions of teachers and prospective teachers, what are the positive and negative aspects of smart board use in the lessons and what are their suggestions for more effective use of smart boards?

Method

In this study, a mixed method in which quantitative and qualitative methods were used in combination was used in order to determine the effect of smart board use on academic achievement of students. In the quantitative phase of the study, meta-analysis method was preferred to determine the effect of smart board use on academic achievement. Meta-analysis method is a method that allows to combine and reinterpret the results of quantitative studies conducted by different researchers in a specific subject/area independently from each other with different place, time and sample groups.

Meta-analysis method makes it possible to obtain more general and valid results related to the subject by combining the studies carried out in a specific subject/area according to certain criteria and by dealing with these studies with a systematic and holistic approach (Littel, Corcoran & Pillai, 2008). In the qualitative phase, the positive and negative aspects of smart board use was determined based on the opinions of prospective teachers and teachers and their suggestions about possible actions to use smart boards more effectively. The most important purpose of qualitative research is to reveal the participants' views about the research topic in depth (Yıldırım & Şimşek, 2011).

Collection and Analysis of Quantitative Data

When collecting quantitative data, a literature review was conducted and primary studies examining the effect of smart board use on academic achievement were accessed. In this context, "smart board and academic achievement", "smart board and achievement", "interactive whiteboard and academic achievement" and "interactive whiteboard and achievement" expressions (in Turkish/English) were entered into Google Scholar, ERIC, Web of Science, and TR Dizin and Higher Education Council National Thesis Center databases and searched. Certain criteria have been taken into consideration in the inclusion of the studies reached as a result of the literature review (see Appendix. Forest Plot Graph). These criteria are as follows:

- ✓ Conducted between 2000 and 2019
- ✓ Thesis, article or proceeding.
- ✓ Conducted in Turkey and the Turkish Republic of Northern Cyprus
- ✓ Full text of the study is accessible
- ✓ Double-group (experimental and control) experimental studies
- ✓ Pre-test and post-test measurement results of the experimental and control groups are available (mean, standard deviation, and sample size, or values such as p and t-test).

As a result of the literature review, 47 studies that met the inclusion criteria were obtained. The total sample size of these studies was 2920 (1476 experimental and 1444 control group). Descriptive data about these studies are shown in Table 1.

Table 1. Descriptive Data about the Studies

Year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Number of publications	2	3	-	4	4	8	6	5	1	3	5	6

Type of publication		School Level		Sample Size	
Article	13	Primary	3	50≤ n	24
Thesis	32	Secondary	26	50< n≤100	17
Proceeding	2	High School	8	100<n	6
		University	9		
		Training center (high school graduates)	1		

Courses in which the application is performed					
Mathematics	16	Turkish	2	English	1
Science and Technology	14	Visual Arts	2	Social Sciences	1
Biology	4	Geography	1	Coding	1
Physics	3	Clothing	1	Capital Markets	1

After the studies were saved in a folder, they were examined one by one and a "Meta-Analysis Data Collection Form" was created. This form was created by entering information such as the author's name, publication year, number of samples, mean, standard deviation, sample size, p and t-test values, province, school level, class, course and experiment duration of the study. Data were analyzed with CMA 2.0 software. Since the studies included in the meta-analysis were not functionally equal and the aim was to generalize the effect size to be obtained to a larger sample, the data were analyzed according to the Random Effects Model (REM) (Borenstein, Hedges, Higgins, & Rothstein, 2017). In this study, ―Standardized Difference in Means" also known as Cohen's d statistic was preferred for the calculation of effect size. Thalheimer and Cook's (2002) classification was used to interpret the effect size [-.15 ≤ d < .15 insignificant; .15 ≤ d < .40 small effect size; .40 ≤ d <.75 moderate effect size; .75 ≤ d <1.10 large effect size; .1.10 ≤ d <1.45 very large effect size; 1.45 ≤ d massive effect size].

Collection and Analysis of Qualitative Data

In the qualitative phase of the study, maximum-variation sampling method was used and 20 prospective teachers studying in different programs (Science and Technology, Turkish, Preschool, Social Studies and Classroom Teaching) in Kilis 7 Aralik University/Muallim Rifat Faculty of Education and 14 teachers from difference majors (Turkish, Social Studies, Science and Technology, Mathematics, History, Music, Art, Geography and Classroom Teaching) working in schools affiliated to Ministry of National Education were included in the study. The semi-structured interview form prepared by the researcher was used to collect the research data. In the interview form, 3 questions were asked to the participants (positive aspects of using smart boards in education, disadvantages of using smart boards in education, and what needs to be done to use smart boards more effectively). Before the interview, the participants were informed about the subject and duration of the interview. The answers of the participants were noted by the researcher. After the interview, the answers noted were read to the participants and their accuracy was confirmed. Interviews lasted an average of 30 minutes. The data were analyzed by using descriptive and content analysis methods. Three themes were identified by the researcher based on the research questions. Then, the answers given to the questions were subjected to content analysis. Codes were formed based on similar data and classified under the relevant themes. Codes were assigned to the participants before data analysis. Prospective teachers were coded as (PT1, PT2, PT3,…, PT20) and teachers as (T1, T2, T3, ..., T14). In order to ensure the reliability of the study, the data were also coded by another researcher (Creswell, 2013). Coding reliability was examined by the method suggested by Miles & Huberman (2002) and the reliability was calculated as 94%. This value was evaluated as sufficient coding reliability. Maxqda computer software was used in the analysis of qualitative data. The themes and codes were visualized through the software and the findings were interpreted by direct excerpts from the participants' statements and views.

Results

Findings Related to Quantitative Data

In the quantitative phase of the study, publication bias was initially examined in terms of the studies included in the meta-analysis. Publication bias is a concept that states that some of the studies on a particular subject are not

included in the meta-analysis for various reasons. Such a situation often leads to deviations in the calculated effect size (Borenstein et al., 2013; Field & Gillett, 2010). Funnel Plot graph, Clasic Fail Safe N and Egger test results were used to examine publication bias. The Funnel Plot graph for the studies included in the research is shown in Figure 1.

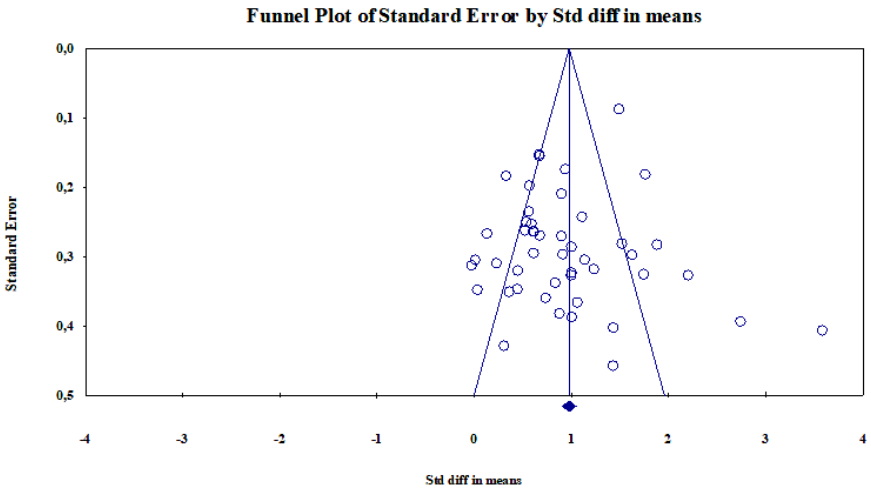

Figure 1. Funnel Plot Graph

When the Funnel plot graph shown in Figure 1 is examined, it is seen that the effect size of the studies included in the meta-analysis is distributed almost symmetrically. Therefore, it can be stated that there is no apparent publication bias. However, other test results should also be examined. Classic Fail Safe N test result tells us that 7137 studies are required to prevent publication bias. Since it is not possible to access that many studies, this can be interpreted as lack of publication bias. When the findings obtained from the Egger test were examined, it was seen that the p value was .349. A non-significant p value (p>.05) means that there is no publication bias. The meta-analysis results of the studies examining the effect of smart board use on academic achievement are shown in Table 2.

Table 2. Meta-analysis Results

				% 95 Confidence Interval		Heterogeneity		
Models		k	ES(*d*)	Lower limit	Upper limit	Q	p	I2
Random Effects Model		47	.94	.77	1.12	253.23	.000	81.84
Fixed Effects Model		47	.98	.91	1.05			
Moderator Effects		k	ES(*d*)	Lower limit	Upper limit	Q_b	p	
Publication Type	Proceeding	2	.38	-.38	1.14			
	Article	13	.82	.52	1.11	2.30	.316	
	Thesis	32	.95	.76	1.14			
School Level	Primary	3	1.08	.49	1.68			
	Secondary	26	.91	.70	1.12	2.84	.417	
	High School	8	.96	.59	1.34			
	University	9	.61	.25	.97			
Scientific Field	Science	21	.89	.67	1.12			
	Visual Arts	2	1.31	.62	2.00			
	Mathematics	16	.71	.32	1.82	5.43	.246	
	Social Sciences	2	1.07	.32	1.82			
	Turkish	2	1.41	.68	2.13			
Year of Publication	2008-2011	9	.52	.18	.86			
	2012-1015	23	.99	.78	1.20	5.55	.062	
	2015-2019	15	.95	.67	1.24			
Sample Size	n≤50	24	.82	.59	1.05			
	50<n≤100	17	1.02	.74	1.29	1.33	.514	
	100<n	6	.82	.41	1.24			
Period of application (weeks)	n<5	25	.99	.78	1.20			
	5≤n<10	13	.75	.47	1.03	3.85	.278	
	10≤n	5	.59	.12	1.06			
	Unknown	4	1.07	.56	1.57			

As can be seen in Table 2, analysis results based on the random effects model reveal that the overall effect size of smart board use (*compared with traditional tools*) on academic achievement was .94 [.77; 1.12]. This value is classified as "*large effect size*" according to Thalheimer and Cook's (2002) effect size classification and it is significant ($p<.05$). When the heterogeneity values are examined, it is seen that the effect sizes of the studies included in the research are heterogeneously distributed ($Q = 253.23$; $p<.05$). The I^2 value of 81.84 means that heterogeneity is high (Higgins, Thompson, Deek & Altman, 2003). The high level of heterogeneity indicates the presence of moderator variables affecting the overall effect size. Type of publication, school level, and field of science, year of publication, sample size and duration of application were taken as moderator variables. As a result of the moderator analyses, it was found that type of publication ($Q_b = 2.30$; $p>.05$), school level ($Q_b = 2.84$; $p>.05$), field of science ($Q_b = 5.43$; $p>.05$), year of publication ($Q_b = 5.55$; $p>.05$), sample size ($Q_b = 1.33$; $p>.05$) and duration of application ($Q_b = 3.85$; $p>.05$) had no moderator effect. In other words, the effect size of smart board use on academic achievement is not affected by variables such as type of publication, school level, field of science, year of publication, sample size, and duration of application.

Findings Related to Qualitative Data

Three themes were determined as a result of the analysis of qualitative data. These themes are *the positive aspects* of using smart board in education, *the negative aspects* of using smart board in education *and the suggestions* for more effective use of smart boards. These three themes and codes of the themes are as shown in the model presented in Figure 2.

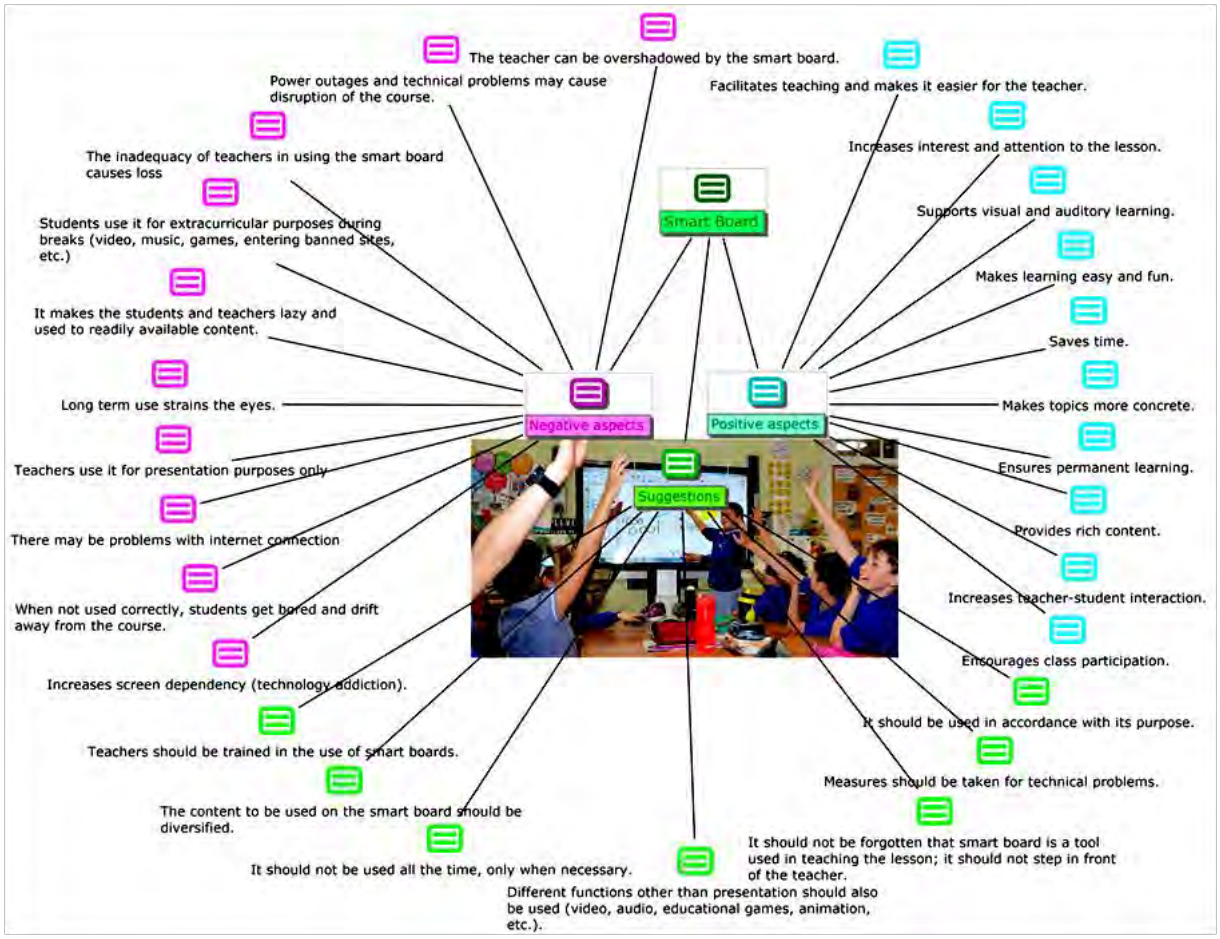

Figure 2. Positive and Negative Aspects of Using Smart Boards and Suggestions for more Efficient Use of Smart Boards

In Figure 2, under the theme of the positive aspects of using smart boards, which was created according to the opinions of the participants, the following codes were emphasized: "provides permanent learning", "supports visual and auditory learning", and "makes subjects more concrete". Direct excerpts from the participants' views on these themes and codes are as follows: *The benefits of using smart boards in classes make it easier to attract the attention of the student during the lesson. It enables us to address more sense organs and provide more*

permanent learning... (T8), keeps attention alive for longer, supports visual and auditory teaching... (PT12), makes the subject more concrete and permanent... (PT16).

In Figure 2, under the theme of the negative aspects of using smart boards, the following codes were emphasized: "inadequacy of teachers in using the smart board leads to a loss of time and a disrupts the lesson", "the teacher can be overshadowed by the smart board", "makes the teacher and students lazy and used to ready content". Direct excerpts from the participants views on these themes and codes are as follows: *There are teachers who do not know how to use smart boards, so they lose time. When the teacher asks for help from the students for using the smart board, the teacher's image in the eyes of the students is damaged… (PT18), the smart board can overshadow the teacher because it is an attractive element in the classroom... (PT1), I think that it limits the imagination of children. I think it reduces children's writing and drawing skills. It stops children from researching things in the library and from books and gets children used to ready content… (T13).*

In Figure 2, under the theme of the suggestions for more effective use of smart boards, the following codes were emphasized: "Teachers should be trained for using smart boards", "Different functions should be used besides presentation (video, audio, educational games, animation etc.)", "Smart boards should not be used all the time, only when necessary". Direct excerpts from the participants' views on these themes and codes are as follows: *Teachers should initially be given in-service training for the use of smart boards, and they should be taught to use the smart board consciously... (PT14), if teachers can show their students useful short films, animated films or documentaries appropriate to their grade instead of only presentations, they can facilitate useful, fun and permanent learning... (PT7), First of all, teachers should use the smart board more consciously and appropriately, they should not use the smart board all the time during lesson, only when necessary... (T3).*

Conclusion, Discussion and Recommendations

In this research, the effect of smart board use in education on academic achievement was examined using quantitative and qualitative methods. In the quantitative phase of the research, 47 experimental studies investigating the effect of smart board use on academic achievement and meeting the inclusion criteria were accessed to. The results of these studies were combined according to random effects model using meta-analysis method. Based on the result of the analysis, it was found that the effect size of smart board use on academic achievement was positive, "large", and significant. Based on this finding, it can be stated that the use of smart boards (compared with traditional tools) in courses has a positive effect on academic achievement. When the meta-analysis studies on the subject are examined, it is seen that the use of smart boards has a positive effect on the academic achievement of students (Batdı, 2017; Saraç, 2017; Gündüz & Kutluca, 2019; Liao, 2013; Shi, Yang, Zhang, Wang & Yang, 2019). In the meta-analysis study conducted by Batdı (2017) using 25 experimental studies published nationally and internationally, the effect size of smart board use on academic achievement was found to be positive, moderate, and significant. In the meta-analysis study of Gündüz and Kutluca (2019) examining the effect of smart board use on achievement in science and mathematics courses, the results of 25 experimental studies were combined with the meta-analysis method and a positive, large and significant effect was found. In the meta-analysis study of Saraç (2017) examining the effect of smart board useon learning outcomes, it was concluded that the effect size of smart board use on academic achievement was positive, large, and significant. It was found that the effect size of smart board use on the students' attitude towards the lesson and the permanence of learning were also positive, large, and significant in the same study. In a meta-analysis of 68 studies conducted by Liao (2013), it was found that the use of smart board increased academic achievement compared to traditional methods. If we make an overall assessment based on the results of all these studies, it can be said that the use of smart boards in lessons positively affects the academic achievement of students.

As a result of the moderator analysis to determine whether the calculated effect size was influenced by the variables of publication type, school level, field of science, publication year, sample size and duration of experimental implementation, if was found that none of these variables had a significant effect on the effect size of smart board use on academic achievement. In other words, the calculated effect size does not differ according to the type of publication, school level, and field of science, publication year, sample size, and duration of experimental implementation. When the findings obtained from the qualitative phase of the research are examined, it is seen that the data obtained under the theme of positive aspects of smart board use support the data obtained in the quantitative phase of the research. When the statements based on the opinions of prospective teachers and teachers about the use of smart boards in the lessons are examined, it is seen that smart boards attract the interest and attention of the students through visual and auditory stimulants, make course contents concrete, provide rich learning content, make learning easy and fun, increase student participation in

the course, reduce time losses and make it easier for the teacher to teach the lesson. These results are similar to the results obtained in many qualitative studies on the subject (Batdı, 2017; Akbaş & Pektaş, 2011; Önder & Aydın, 2016; Polat & Özcan, 2014; Karakuş & Karakuş, 2017; Çoklar & Tercan, 2014). From the opinions of the participants, it is seen that there are some negative aspects as well as positive aspects of smart board use. When the codes under this theme are examined, it is seen that inadequacy of teachers on the use of smart board can lead to loss of time and disruption of the course, smart board use can lead to screen addiction in students, teachers teaching the course only by making presentations get the students bored and distract their attention, the smart board can overshadow the teacher as an attractive object in the classroom, and make the teacher and students lazy through readily available content. These findings overlap with the results of other studies conducted on the subject (Batdı, 2017; Karakuş & Karakuş, 2017; Kutluca & Tum, 2018). When the codes under the theme of suggestions for more effective use of smart boards are examined, it is seen that suggestions such as diversifying the content to be used in smart boards, training teachers about smart board use, not using the smart boards all the time and only when necessary, using the smart boards in accordance with their purpose, using different functions besides presentation, taking necessary measures for technical problems are emphasized by teachers and prospective teachers. These results are supported by the results obtained from the meta-thematic study by Batdı (2017) in which 14 qualitative studies were synthesized. In that study, suggestions such as the necessity of training teachers about the use of smart boards and diversification of the content to be used on smart boards were emphasized. Based on the findings obtained, it can be said that using smart boards in courses positively affects academic achievement, but not using smart boards correctly may have consequences that may adversely affect achievement.

This research is important in terms of meta-analytical and thematic analysis of the effect of smart board use on academic achievement. However, there are certain limitations of the research. In the quantitative phase, this research is limited to studies conducted in Turkey and Turkish Republic of Northern Cyprus. Therefore, the results can only be generalized to these countries. This research is limited to studies for which full texts could be accessed. Some studies could not be included in the meta-analysis because they did not grant access to the full text. Most of the studies were conducted within the scope of science and mathematics courses. The number of studies on other courses is limited. This is seen as one of the important limitations of the research. In the qualitative phase, the results obtained are limited to the opinions of prospective teachers and teachers. Researchers who will conduct further studies on this subject can get the opinions of other educational stakeholders with experience on smart board use and obtain more comprehensive results.

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Appendix. Forest Plot Graph

Model	Study name	Std diff in means	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value
	Akbas & Pektas, 2011	0,36	0,35	0,12	-0,33	1,05	1,03	0,30
	Akcayir, 2011	0,67	0,15	0,02	0,37	0,97	4,38	0,00
	Akdemir, 2009	-0,03	0,31	0,10	-0,64	0,59	-0,08	0,94
	Akgul, 2013	1,49	0,09	0,01	1,32	1,66	16,95	0,00
	Aktas, 2015	0,56	0,24	0,06	0,10	1,02	2,39	0,02
	Alan, 2019	1,00	0,29	0,08	0,44	1,56	3,50	0,00
	Aydin, 2017	0,74	0,36	0,13	0,03	1,44	2,05	0,04
	Batdi, 2017	0,54	0,25	0,06	0,05	1,03	2,14	0,03
	Bicak, 2019	1,75	0,33	0,11	1,11	2,38	5,36	0,00
	Canlibel, 2018	0,13	0,27	0,07	-0,39	0,66	0,50	0,62
	Cetinkaya, 2019	0,45	0,32	0,10	-0,18	1,08	1,40	0,16
	Demir, 2019	3,58	0,41	0,17	2,79	4,38	8,81	0,00
	Dikmen, 2015	1,63	0,30	0,09	1,04	2,21	5,46	0,00
	Ekici, 2008	0,62	0,26	0,07	0,10	1,13	2,33	0,02
	Emre et al., 2011	0,23	0,31	0,10	-0,38	0,84	0,74	0,46
	Emris, 2012	0,45	0,35	0,12	-0,23	1,13	1,29	0,20
	Ertan et al., 2011	0,31	0,43	0,18	-0,53	1,15	0,72	0,47
	Gencoglu, 2013	0,88	0,38	0,15	0,13	1,63	2,30	0,02
	Gursoy, 2014	1,06	0,37	0,13	0,35	1,78	2,90	0,00
	İnce, 2008	1,52	0,28	0,08	0,97	2,07	5,40	0,00
	Karaman, 2019	1,43	0,46	0,21	0,53	2,33	3,13	0,00
	Kaya, 2013	1,43	0,40	0,16	0,64	2,22	3,56	0,00
	Kaynak & Unal, 2018	1,00	0,33	0,11	0,36	1,64	3,05	0,00
	Keser, 2012	2,20	0,33	0,11	1,56	2,85	6,73	0,00
	Kirbas, 2018	1,88	0,28	0,08	1,33	2,44	6,65	0,00
	Onder, 2015	2,74	0,39	0,16	1,97	3,51	6,96	0,00
	Ozcelik, 2015	0,83	0,34	0,11	0,17	1,50	2,47	0,01
	Ozenc & Ozmen, 2014	0,61	0,30	0,09	0,03	1,19	2,08	0,04
	Oztan, 2012	1,00	0,32	0,10	0,37	1,64	3,10	0,00
	Pekel & Matyar, 2016	0,90	0,27	0,07	0,37	1,43	3,32	0,00
	Sakiz et al., 2014	1,11	0,24	0,06	0,63	1,59	4,57	0,00
	Sari & Guven, 2013	0,57	0,20	0,04	0,18	0,96	2,88	0,00
	Sarikaya, 2015	0,90	0,21	0,04	0,49	1,31	4,29	0,00
	Sen, 2013	0,94	0,17	0,03	0,60	1,28	5,39	0,00
	Tataroglu, 2009	0,33	0,18	0,03	-0,03	0,69	1,79	0,07
	Tayfa, 2018	0,91	0,30	0,09	0,33	1,50	3,07	0,00
	Tekin, 2013	0,67	0,16	0,02	0,37	0,98	4,33	0,00
	Tercan, 2012	0,59	0,25	0,06	0,10	1,09	2,34	0,02
	Tezer & Deniz, 2009	0,52	0,26	0,07	0,01	1,04	2,00	0,05
	Tiryaki, 2014	1,76	0,18	0,03	1,41	2,12	9,68	0,00
	Tufekci, 2019	1,14	0,30	0,09	0,54	1,74	3,73	0,00
	Tunaboylu & Demir, 2017	0,68	0,27	0,07	0,15	1,20	2,50	0,01
	Turan, 2014	1,23	0,32	0,10	0,61	1,86	3,88	0,00
	Turkoglu, 2014	0,01	0,31	0,09	-0,59	0,61	0,04	0,97
	Uzun, 2013	0,04	0,35	0,12	-0,65	0,72	0,10	0,92
	Yagci, 2018	1,01	0,39	0,15	0,25	1,77	2,60	0,01
	Yorgancı & Terzioglu, 2013	0,61	0,26	0,07	0,09	1,13	2,31	0,02
Fixed		0,98	0,04	0,00	0,91	1,05	27,02	0,00
Random		0,94	0,09	0,01	0,77	1,12	10,58	0,00