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The effect of digital story applications on students' academic achievement: A meta-analysis study

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ABSTRACT

The digital story, which is considered as a method that focuses on students, and makes them engaged in the learning process, presents a profile suitable for student-centered modern education systems with this feature. For this reason, digital story has become a subject frequently studied in educational research for the last 20 years. In this study, it is aimed to synthesize the results obtained from experimental studies on the effect of digital story method on students' academic achievement. The studies examined within the scope of the research have been accessed by using the keywords "digital story, digital storytelling, academic achievement" in Web of Science, ERIC, EBSCOhost, ULAKBİM TR Index, Google Academic and YOK Dissertation databases. According to the results obtained from the analyzes performed according to random effects model at 95% confidence interval using the Comprehensive Meta-Analysis (CMA) software, the average effect size was estimated as 0.750. According to Cohen et al. (2011), this result indicates a high level of impact of digital story applications on increasing students' academic achievement. In educational processes using digital story and other teaching methods, students' academic achievement differences were examined in line with the moderator variables. While the type of course and teaching level variables make a significant difference on the effect sizes of the studies, the type of publication and the study origin variables did not make a significant difference.

Keywords: Digital story, digital storytelling, academic achievement, meta-analysis.

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INTRODUCTION

Digital story and academic achievement

Digital storytelling, which is the result of the integration of traditional storytelling with technology, enables students to form their own stories and interact with them, on the one hand, and differs from traditional storytelling on the other because it uses information and communication technologies (Dörner et al., 2002).

Digital story with increased areas of use in different disciplines recently is generally described as short, individual and multimedia stories that share information using multimedia tools or resources (Meadows, 2003 and Yüksel, 2011). The foundations of the digital story, which expresses the digital narration of stories for a specific purpose, were laid in the USA in the 1970s and 1980s. The Digital Media Center, which was established in San Francisco in 1994, moved to Berkeley in 1998 and became a Digital Storytelling Center, and this center has worked with many institutions and organizations from different parts of the world, forming the basis for workshops that will teach digital storytelling skills in the following years (Center for Digital Storytelling, 2020). This center stated that digital storytelling has 7 components. These are as follows (Lambert, 2003 and Bull and Kajder, 2004):

1. Perspective
2. A Dramatic Question
3. Emotional Content
4. Economy
5. Voice
6. Music
7. Pacing / Rhythm

The first four of these components are related to the content and writing of the story, while the others are

related to the formation of the story. Robin and Pierson (2005), on the other hand, talked about the 10 components by adding the “Story Purpose, “Image Quality” and “Good Grammar and Language Use” components to these 7 components in order to provide the use of digital storytelling for educational purposes.

Today, although digital storytelling is used in many different fields, it has also been used in education and training processes to achieve instructional goals. Digital story, which is inherently a suitable method in terms of contemporary educational approaches, has become a popular pedagogical tool used by different teachers of specialization for students of all ages and all levels to learn (Garcia and Rossiter, 2010). Considering the uses of the digital story in educational settings, it seems that it is used for the purpose of presenting a specific course content as a teaching material and for purposes such as students learning a specific course content, telling an imaginary or personal story, telling a historical event, giving information about a particular subject, motivation and presentation (Robin, 2008, 2006).

Technology is necessary and indispensable to make easy, regularize, make sense to human life. (Alyılmaz, 1997). The use of digital story that is one of technology products has brought many qualities to educational environments. Digital story method, which is a method where students are more active, realize their own characteristics and use technology more effectively, supports learning to become more permanent with these opportunities. In addition, it provides students with an environment where they can express themselves more comfortably, provide students with opportunities to use the technological infrastructure brought by the era, prepare the environment for the individuals who produce and use the information, make the students active and encourage them to solve the problems they encounter, and contribute to the reinforcement of the learned information, and it has a crucial and effective role in acquiring skills such as reflective thinking expected from students in the 21st century, as well as skills such as digital literacy, global literacy, information literacy, technological literacy and visual literacy. And, these are important qualities that digital story usage provides in educational processes (Jakes and Brennan, 2005; Robin, 2008; Turgut and Kışla, 2015; Ayvaz Tunç and Karadağ, 2013; Karakoyun, 2014). All of these are also noteworthy in terms of showing the impact of the use of digital stories on academic achievements of students.

The word achievement, which means succeeding and thriving, also means achieving the targeted purpose (TDK, 2011). Wolman (1973) defines success as progress towards achieving a targeted result and draws attention to the wide scope of the word success. The word 'success', which has such a wide scope of meaning, is understood as academic achievement, which means the success achieved by people in the lessons at school, receiving grades appreciated by teachers, and getting high scores from tests (Carter and Good, 1973).

Academic achievement is the equivalent of success in the field of education, and refers to the result of the educational experience (Travers, 1970), the student's ability to exhibit the gains expressed in the curriculum, the progress that the student has made in achieving the results determined according to his or her own education level.

Many studies investigating the effect of using digital stories on academic achievement in educational processes have taken their place in the literature. Some of those are provided as examples below:

In his research, Banaszewski (2005) interviewed 20 teachers carrying out a digital storytelling project and concluded that the use of digital stories has positive effects on students' digital and normal literacy development and supports digital literacy.

In their studies with 19 kindergarten students, Papadimitriou et al. (2013) examined the students' commitment to interaction, motivation and learning in the process of digital story development.

As a result of the analysis of the data, the researchers came to the conclusion that the students had a positive interaction, their motivation levels were high in the process, their self-confidence, responsibility and cooperation skills improved, their interest in technological tools increased and they were connected to the whole process.

In his empirical study, where he investigated the effect of digital story usage on students' academic achievement, attitudes towards classes, motivations and learning strategies, Demirer (2013) concluded that the use of digital stories increases students' academic achievements, attitudes and motivations towards the lesson, their ability to use technology, and contributes to interaction and sharing.

Yang and Wu (2012) concluded in their study where they investigated the effect of digital story use on students' academic achievement, critical thinking skills and learning motivations in English lessons that the use of digital stories in English lessons provides students with significant improvement in the areas of English listening, reading, writing, interpretation and evaluating claims, English proficiency, critical thinking and learning motivation.

Yılmaz et al. (2017), aimed to reveal how the Turkish lessons taught through digital stories affect students' reading and writing skills in their experimental studies. According to the results obtained by the researchers, the Turkish lessons taught with the digital story method demonstrated that the students had positive results on their reading and writing skills, and the opinions of the students and the teachers about the digital story method were positive.

Meta-analysis

Meta-analysis is “statistical methods and techniques used

for statistical integration of the results of previously conducted independent studies. Although it is considered as an analytical technique used to summarize the results of many different studies, it is also considered as a research method" (Bakioğlu and Özcan, 2016, p. iii).

Meta-analysis is a statistical method used to combine the results of similar studies in a field (Ergene, 1999; Bakioğlu and Özcan, 2016, p. 5).

Meta-analysis is a method used to analyze information that is quantitatively called effect size, via transferring and then merging data from individual studies by reviewing the research results (Durlak, 2003; Bakioğlu and Özcan, 2016, p. 6).

Not every study that focuses on research results is a meta-analysis study. Meta-analysis differs from other analysis methods by the synthesis method it uses to obtain findings from the results (Bakioğlu and Özcan, 2016).

Meta-analysis, which is a method used in summarizing, combining and interpreting scientific research, has feasible or impractical situations according to the results obtained from the studies collected on the subject to be studied. The meta-analysis method, which is used to re-analyze the result statistics, which are summarized in the empirical research results, the result reports where quantitative measurements are made, or the studies made on descriptive data and research reports, cannot be applied in summarizing theoretical studies, policy proposals, case studies, qualitative studies, and researches related to natural knowledge (Bakioğlu and Özcan, 2016).

Meta-analysis, which is a method used in the health sciences at first, has started to become widespread and used in other science fields over time. The lack of sufficient resources related to meta-analysis in our country and misclassifications and misinterpretations prevented the meta-analysis method from becoming widespread in our country, or at the very least delayed it. Although meta-analysis has not achieved the place it deserves in our country, it is a popular analysis method used all over the world for a long time. Nowadays, resources related to meta-analysis, which are being used in fields such as medical sciences, social sciences, natural sciences, and educational sciences, have started to take their place in the literature (Dinçer, 2014; Bakioğlu and Özcan, 2016; Lipsey and Wilson, 2001; Schulze, 2007).

Research objective

In addition to being based on technology, digital stories also emerge as a suitable method for the philosophy of the constructivist education that has been put in the center in our country recently, in terms of addressing more than one sense of students during the learning process. Digital story, which is a method that makes students' learning much more enjoyable and facilitates teaching activities for teachers, is among the topics that have been studied a lot recently both worldwide as well as in our country. In this context, most of the experimental researches investigating the effects of digital story use on students' academic achievement report the superiority and effectiveness of digital story method over other teaching methods. The results obtained from these researches indicate that digital story applications should be used more frequently in the education and training processes.

Despite the fact that such individual studies have found considerable venue in the literature, there are no inclusive and reliable high-level studies that will lead to new researches by interpreting the knowledge accumulated by synthesizing the data obtained from these studies. For this reason, it was decided to conduct this meta-analysis study in order to reach more precise and generalizable conclusions about the effect of the classes taught with the digital story method on the academic achievement of the students compared to the classes taught with other teaching methods. In this context, the purpose of this meta-analysis study is stated as determining the effect of classes taught using digital story method on academic achievement of students. The following research problems were answered in line with this objective:

1. Is there any difference between the academic success of the students in the lessons taught with digital story applications and the lessons taught using other method techniques?
2. Is the difference between the academic achievements of students in the lessons taught with digital story applications and the lessons taught using other methodology techniques significant according to the moderator variable of publication type?
3. Is the academic achievement of students in classes taught with digital story applications significantly different from the classes taught using other methodology techniques according to the moderator variable of level of education?
4. Is the difference between the academic achievement of the students in the lessons taught with digital story applications and the lessons taught using other method techniques significant according to the moderator variable of class type?
5. Is the difference between the academic achievements of the students in the lessons taught with digital story applications and the lessons taught using other method techniques significant according to the study origin (Turkey/Foreign) moderator variable?

METHODOLOGY

Research model

In this study, meta-analysis method was used to

synthesize the results of the experimental studies that investigated the effects of the lessons taught using the digital story method on students' academic achievement.
“Meta-analysis is the application of statistical procedures used to combine, synthesize and interpret experimental findings from individual studies” (Bakioğlu and Özcan, 2016, p. 5). According to another definition, meta-analysis is “briefly the analysis of other analyzes. It combines the results of other studies in a consistent and harmonious way” (Cohen et al., 2000, s. 222).

Data collection

Research data were collected in April 2020. In order to determine the studies to be examined within the scope of meta-analysis, literature was reviewed by using the keywords "digital story, digital storytelling, academic achievement" in Web of Science, ERIC, EBSCOhost, ULAKBİM TR Index, Google Scholar, and YOK (Council of Higher Education) Dissertation Databases. As a result of these reviews, 83 studies (articles and theses) investigating the effect of digital story method on students' academic achievements were found.
While deciding on the studies to be included in the scope of meta-analysis, the following criteria were used:

1) Studies must be published between the 2000 – 2020.
2) The publication language of the studies should be Turkish or English.
3) Studies should be published as postgraduate dissertation or scientific articles.
4) Information on the validity and reliability of the measurement tools used in these studies should be included.
5) In the studies, digital story method should be used in the lessons taught with the experimental group, and one of the other teaching techniques should be used in the lessons taught with the control group.
6) In the researches, the effect of using digital stories on students' academic success should be investigated.
7) Studies should include the statistical data required to calculate the effect size.

The researches obtained as a result of the first reviews were re-examined according to these criteria, and 38 studies (articles and dissertations) were not included in the scope of meta-analysis since they did not meet these criteria. After these omissions, a total of 45 different studies that were found to be compatible with the above criteria were included in the scope of meta-analysis. In some of these studies, the effect of digital story on more than one academic achievement area has been investigated, and each academic achievement area has been considered as a separate study and included in the meta-analysis. Thus, starting from these 45 studies (articles and thesis) included in the scope of meta-analysis, the effect sizes of 94 different studies in total in meta-analysis were estimated, with the topic of the effect of the digital story on students' academic achievement.

Data coding

Before the meta-analysis, the researchers created a coding form in order to outline the studies in the literature on digital story and noted the following information about the studies in this form:

• The identification of the study (name, author, year of publication, and type of publication)
• Study area
• Subject of the study
• Study design, method, technique
• Duration of experimental operations
• Sample size of treatment and control groups
• Teaching level and grade level of the study group of the research
• Study Origin (Domestic / Foreign)
• Availability of validity and reliability information about measurement tools used in the study.

In order to ensure the reliability of the coding, coding was completed separately with two academicians with a doctor title in the field of Turkish education and one academician with a doctor title in the field of measurement and assessment. In cases where there are different opinions, three academicians came together, and resolved their differences with a necessary consensus on parts, which they have had disagreement on. The reliability formula of Miles and Huberman (1994) was used to express the reliability of the coding statistically. As a result of the estimations, the reliability rate was found to be 97%. This result shows that the coding is reliable.

Data analysis

In the study, where all analyzes are performed with Comprehensive Meta-Analysis (CMA) software, test of heterogeneity was performed to determine which model (fixed effects / random effects) should be performed for meta-analysis. Whether the studies examined within the scope of meta-analysis were distributed heterogeneously were analyzed with Q value and I2 statistics. The effect size value of each of the 94 studies examined within the scope of meta-analysis was calculated by the researcher one by one. In this context, Cohen's d value and variance value of each study was calculated, the format, in which the common effect size value can be calculated while entering data in the CMA software, was chosen by using the Cohen d coefficient, and all calculations were performed within the 95% confidence interval. When interpreting the effect sizes, the criteria of Cohen et al.

(2011) were taken into consideration (Dinçer, 2014).

-0.15 ≤ Effect size value ≤ 0.14 (Insignificant Effect),
0.15 ≤ Effect size value ≤ 0.39 (Weak Effect),
0.40 ≤ Effect size value ≤ 0.74 (Medium Effect),
0.75 ≤ Effect size value ≤ 1.09 (Strong Effect),
1.10 ≤ The magnitude of the effect value ≤ 1.44 (Very Strong Effect),
1.44 > Effect Size value (Excellent Effect)

Publication bias of the study was calculated separately with funnel plot, Duval and Tweedei's trim and fill method, Rosenthal's fail-safe N statistic and Mullen, Muellerleile and Bryant's publication bias resistance formula.

FINDINGS

In this study, which investigates the effect of digital story applications on students' academic achievements, a total of 94 studies were included within the scope of meta-analysis. Descriptive information for these studies is presented in table 1.

When Table 1 is analyzed, it is observed that a total of 94 studies, 58 of which are postgraduate education dissertations (61.70%) and 36 articles (38.29%), have been examined within the scope of meta-analysis. Considering the years when these studies were published, it is seen that the most studies were done in 2019. In 2019, 24 (25.53%) studies were conducted investigating the effect of digital story use on academic achievements of students. Looking at the other years, it is seen that 20 (21.27%) studies were conducted in 2018, 17 (18.08%) studies conducted in 2017, 8 (8.51%) studies conducted in 2016 and 2014, 5 (5.31%) studies conducted in 2015, 4 (4,25%) studies conducted in 2012 and 2013, 3 (3,19%) studies conducted in 2007, and 1 (1,06%) study conducted in 2020. When the education levels of the sample groups of the studies are examined, it is seen that 24 (25.53%) studies are carried out with 6th grade students. Then, these studies were respectively followed by 11 (11.70%) research on 4th grade students, 9 (9.57%) research on Undergraduate 2nd grade students, 8 (8.51%) research on 5th grade students, 7 (7.44%) research on 3rd year students, 6 (6.38%) research on kindergarten students, 6 (6.38%) research on 2nd grade students, 4 (4.25%) research on 7th grade students, 4 (4.25%) research on 8th grade students, 4 (4.25%) research on 9th grade students, 3 (3.19%) research on 1st grade students, 3 (3.19%) research on 10th grade students, 2 (2.12%) research on prep school students, 1 (1.06%) research on 12th grade students, 1 (1.06%) research on associate degree 1st year students, and 1 (1.06%) research with Turkish students at TOMER B1 level. When the sample sizes of the studies analyzed within the scope of meta-analysis are examined, the number of students in the sample group of 33 studies (35.10%) out of 94 studies is in the range of 51 ≤ N ≤ 70. Out of the remaining 61 studies, it is observed that the number of students in the sample group of 29 (30.85%) studies is in the range of 31 ≤ N ≤ 50, the number of students in the sample group of 11 (11.70%) studies is in the range of 111 ≤ N, the number of students in the sample group of 10 (10.63%) studies is in the range of 91 ≤ N ≤ 110, the number of students in the sample group of 7 (7.44%) studies is in the range of 71 ≤ N ≤ 90, and the number of students in the sample group of 4 (4.25%) studies is in the range of 10 ≤ N ≤ 30. Finally, when the application durations of 94 studies are examined, it is seen that the application duration of a total of 66 (70.21%) studies covers a period of 1 to 10 weeks. It is seen that 20 (21.27%) of the remaining 28 studies resume between 11-20 weeks, and the application period of 5 (5.31%) of the studies covers more than 21 weeks. In 3 (3.19%) studies, no information about the application duration of the study was included.

Findings related to the impact of digital story activities on students' academic achievement

Although the analysis results of 94 studies included in the scope of meta-analysis were expressed in different data types (weighted averages and standard deviations; t value; p value, U value, and sample sizes of experiment - control groups), effect size value for each study was estimated by using these different data types[1]. The total sample size reached in meta-analysis through 94 individual studies is given in the table below:

According to Table 2, a total of 6520 students were collected in the meta-analysis study. 3271 students were in the experimental groups of individual studies and 3749 students were in the control groups.

In meta-analysis studies, analyzes are made according to two different models. These are the fixed effects model and the random effects model. In meta-analysis studies where individual studies are distributed homogeneously, fixed effects model is used, whereas in meta-analysis studies in which heterogeneous distribution is used, random effects model is used. In this context, in order to determine which model to use in the meta-analysis, homogeneity test was conducted to examine whether 94 individual studies are distributed homogenously or heterogeneously, and the results obtained are given in Table 3.

According to Table 3, the Q value was found to be 433,754 as a result of analyzing the homogeneity values of the individual studies included in the meta-analysis according to the fixed effects model. According to the x2 table, the critical value of 93 degrees of freedom at the level of 95% significance is 116,511. These results show

[1] While calculating the effect size values of the studies, https://www.psychometrica.de/effect_size.html and https://campbellcollaboration.org/research-resources/effect-size-calculator.html websites were used.

Table 1. Descriptive information on studies examining the impact of digital story applications on students' academic achievement.

		Frequency	Percentage
Type of the study	Article	36	38.29%
	Dissertation	58	61.70%
Study year	2020	1	1.06%
	2019	24	25.53%
	2018	20	21.27%
	2017	17	18.08%
	2016	8	8.51%
	2015	5	5.31%
	2014	8	8.51%
	2013	4	4.25%
	2012	4	4.25%
	2007	3	3.19%
Level of education of the sample group	Kindergarten	6	6.38%
	First Grade	3	3.19%
	Second Grade	6	6.38%
	3rd Grade	7	7.44%
	4th Grade	11	11.70%
	5th Grade	8	8.51%
	6th Grade	24	25.53%
	7th Grade	4	4.25%
	8th Grade	4	4.25%
	9th Grade	4	4.25%
	10th Grade	3	3.19%
	12th Grade	1	1.06%
	Associate Degree First Year	1	1.06%
	Undergraduate Degree Sophomore	9	9.57%
	TOMER B1 Level	1	1.06%
	Prep-School	2	2.12%
Sample size	$10 \leq N \leq 30$	4	4.25%
	$31 \leq N \leq 50$	29	30.85%
	$51 \leq N \leq 70$	33	35.10%
	$71 \leq N \leq 90$	7	7.44%
	$91 \leq N \leq 110$	10	10.63%
	$111 \leq N$	11	11.70%
Application duration	$1 \leq S \leq 10$	66	70.21%
	$11 \leq S \leq 20$	20	21.27%
	$21 \leq S$	5	5.31%
	No Information	3	3.19%
	Total	94	100%

Table 2. Total sample size in experimental and control groups achieved through individual studies

Sample size achieved through meta-analysis studies	
N (Treatment)	**N (Control)**
3271	3249

that 9 degrees of freedom of Q value (433,754) are greater than the critical value of the chi-square distribution ($x2 = 116,511$ for $df = 93$). This result shows that the individual studies included in the meta-analysis have a heterogeneous structure. In addition, the 78.559% value obtained as a result of the calculation of the I2

Table 3. Test of homogeneity results according to fixed effects model.

Model	Average impact size value (ES)	95% confidence interval for effect size		Standard error (SE)	Homogeneity value (Q)	df (Q)	p	I^2
		Lower bound	Upper bound					
Fixed effects model	0.683	0.632	0.734	0.026	433.754	93	0.000	78.559

value indicates that the studies included in the scope of meta-analysis are of different structure, that is, pointing to a high level of heterogeneity. Finally, when Table 3 is examined, it is seen that p value is 0.000. A p value of less than 0.05 indicates that there is a significant difference between individual studies, that is, the studies are heterogeneous. Thus, the heterogeneity of the study was demonstrated using p value.

Since the individual studies included in the scope of meta-analysis show a heterogeneous distribution, the analysis of the study was made and interpreted using the random effects model.

When Table 4 is examined, as a result of the analysis performed according to random effects model, the average effect size value was calculated as 0.750 and the standard error was calculated as 0.057. The lower bound of the effect size in the 95% confidence interval is 0.637 and the upper bound is 0.862. Based on Cohen et al. (2011), this result demonstrates that the lessons taught using a digital story have a high impact on increasing students' academic achievements. The positive effect size value (+0,750) shows that the procedure is in favor of the experimental group in which the lessons are taught using digital stories. The forest plot showing the distribution of the effect sizes of the studies included in the meta-analysis according to the random effects model is given in Figure 1. The black squares in Figure 1 show the effect sizes of individual studies, and the lines next to the squares indicate the upper and lower limits of the effect sizes in the 95% confidence interval. The percentages of weight on the right side of the graph represent the impact rate of each research on the meta-analysis result. When Figure 1 is examined, it is seen that the study with the widest confidence interval is Gider (2019) and the studies with the narrowest confidence interval are Verdugo and Belmonte (2007). As a result of the meta-analysis performed, it is seen that the studies with the highest weight belong to Verdugo and Belmonte (2007) with a ratio of 1.31%, and that the study with the smallest weight is of Gider (2019) with 0.42% The weight of other individual studies on meta-analysis results varies in various proportions.

Among the individual studies included in the meta-analysis, the study with the smallest effect size value is Uslu (2019) with -0.212, and the study with the largest effect size value is Dinçer (2019) with 3.559. It was determined that 91 studies have positive effects, and 3 studies have negative effects among the studies included in meta-analysis. The fact that almost all the studies have a positive effect shows that the classes taught using the digital story method have a positive effect on academic achievements of students.

The funnel graph showing the publication bias of the studies examined within the scope of meta-analysis is presented in Figure 2. When Figure 2 is examined, it is seen that vast majority of the studies examined within the scope of meta-analysis are clustered inside the funnel graph. This indicates that the studies included in the meta-analysis have high effects on the results obtained. The studies included in the meta-analysis are expected to cluster around the line expressing the overall effect in the middle of the funnel. When Figure 2 is analyzed, it is seen that a vast majority of the studies that are meta-analyzed are clustered around the line and inside the funnel. But, existence of studies lying out of the funnel should also be noted. In addition, research is distributed almost symmetrically in the funnel graph; however, it can be seen in Figure 2 that there are studies that disrupt symmetry on the left side of the funnel. These results mean that the studies included in the meta-analysis may have some publication bias, albeit little. In order to make the funnel plot more symmetrical, the trim and fill method of Duval and Tweedie were used.

Table 4. Average impact sizes and confidence interval lower-upper values according to random effects model.

Model	Average impact size value (ES)	95% Confidence interval for effect size		Standard error (SE)	Homogeneity value (Q)	df (Q)	p	I^2
		Lower bound	Upper bound					
Random effects model	0.750	0.637	0.862	0.057	433.754	93	0.000	78.559

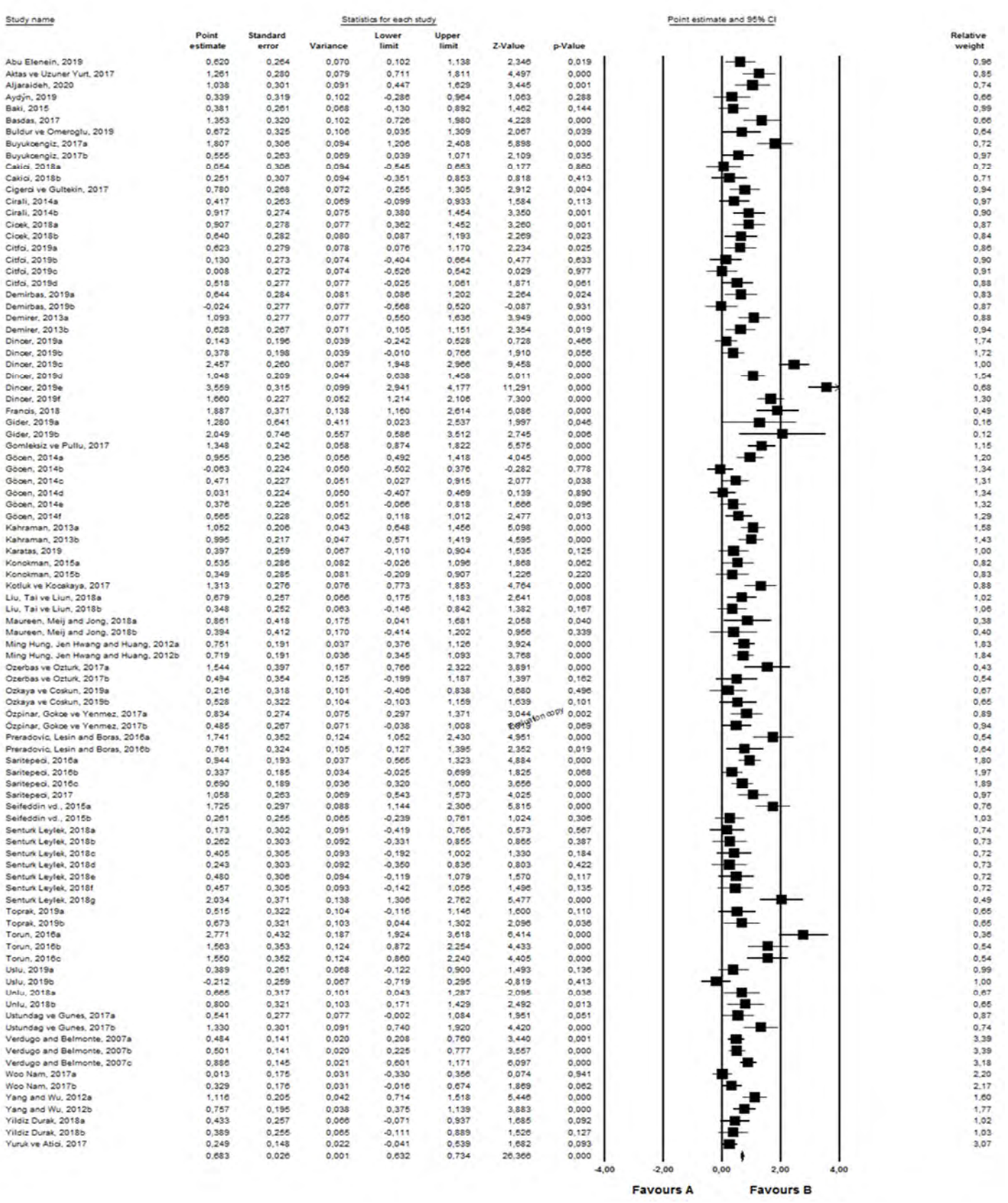

Figure 1. Forest plot showing the effect size of researches by random effects model.

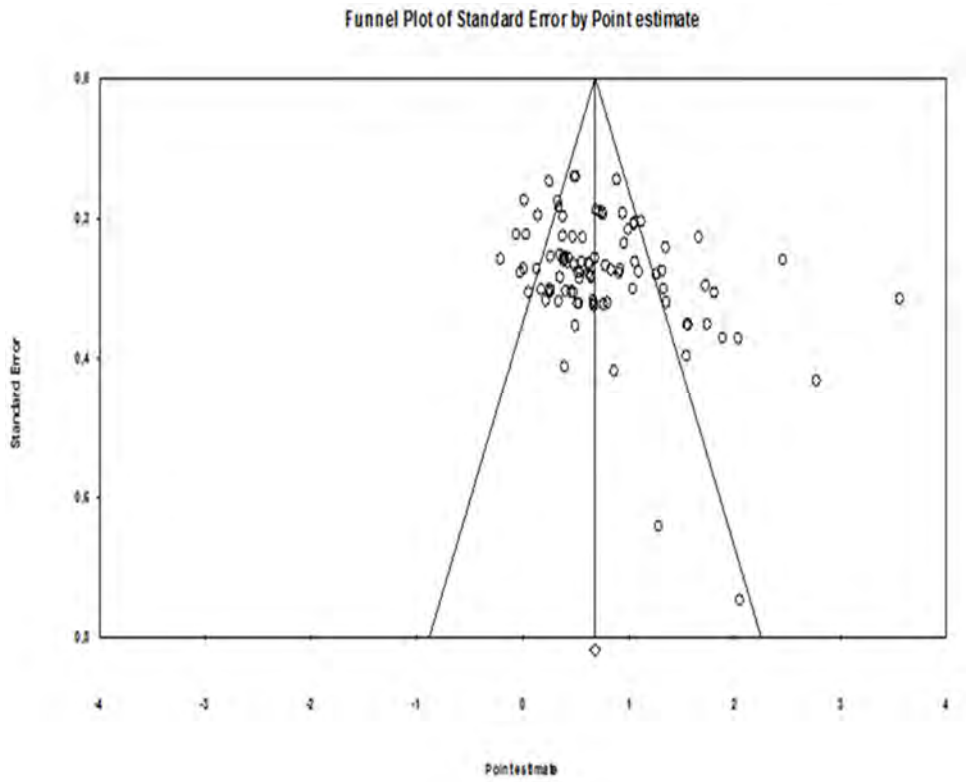

Figure 2. Funnel plot for publication bias.

According to the results obtained, 14 artificial studies have been added to the right side of the funnel in order to balance some of the studies that cause publication bias on the left side of the funnel so that the funnel plot becomes symmetrical (Figure 3). The new effect size value calculated with the addition of these studies is 0.822. The new funnel plot, which appeared with the use of the trim and fill method of Duval and Tweedie, is presented below. According to the trim and fill method of Duval and Tweedie, the lower the number of artificial studies that need to be added to ensure symmetry, the less bias meta-analysis has. Here, 14 studies added to the funnel plot indicate that publication bias in the meta-analysis is low. However, in order to use more precise statements about whether the meta-analysis results have publication bias, Rosenthal's fail-safe N statistics were used and the results are presented below.

According to Table 5, the fail-safe N number was calculated as 7854. This value indicates that in order for the common effect size calculated as 0.750 to be statistically insignificant, 7854 studies with zero effect level should be included in the meta-analysis. This value indicates that the meta-analysis performed is resistant to publication bias. Finally, it has been tested whether the meta-analysis study of using the Mullen et al. (2001) formula has bias. If the value obtained by using the formula N / (5k + 10) is greater than 1, it can be said that the calculated common effect size value does not bear publication bias. As a result of the calculations made using the formula, [7854 / (5 * 94 + 10) = 16.3625] it was found that the value obtained was greater than 1. Accordingly, it can be said that the meta-analysis conducted is resistant to publication bias.

Investigation of the effect of digital story method on academic achievement according to moderator variables

In this section, the effect size value obtained by subjecting the research, which compare the effects of digital story and other teaching methods on academic achievement, on meta-analysis was investigated to observe whether it differed according to the type of publication, teaching level, type of class, and study origin.

In this context, first, whether the type of publication moderator variable makes a significant difference was examined, and the related results are summarized in Table 6.

When Table 6 is examined, it is determined that the type of publication moderator variable does not cause a significant difference on the effect size value ($p > .05$). In other words, the academic achievement of students in courses taught with the digital story method and students in courses taught with other teaching methods and techniques does not differ significantly according to the

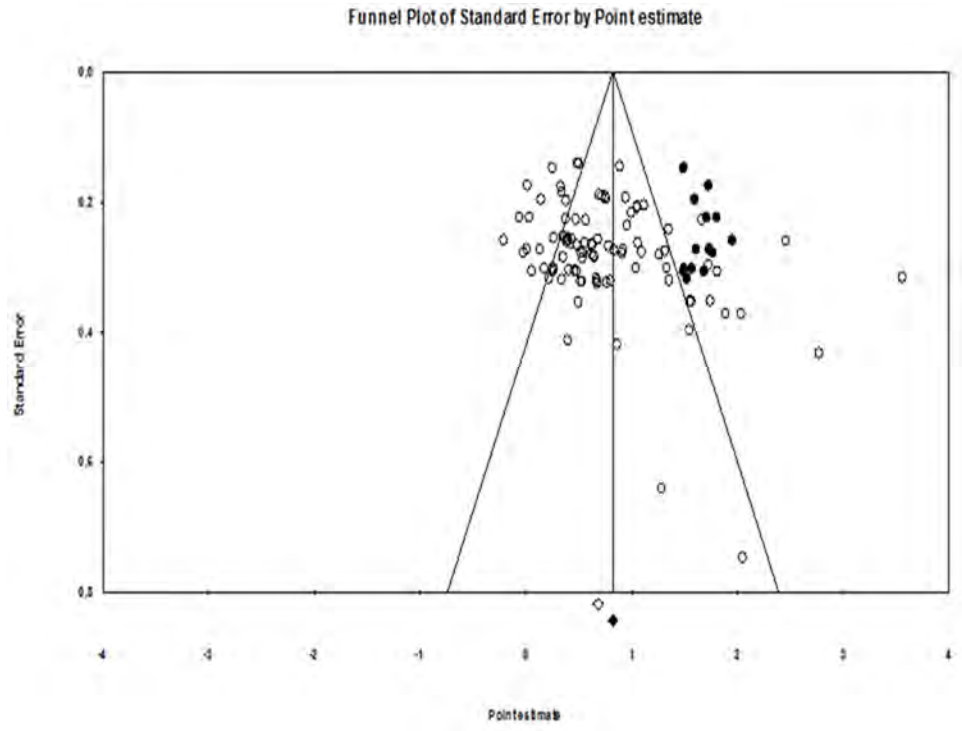

Figure 3. Funnel plot created using the trim and fill method of Duval and Tweedie,

Table 5. Rosenthal FSN Calculation for Meta-Analysis Examining the Effect of the Classes with Digital Story Method applications on Academic Achievements of Students.

Bias status	
Z value for observed studies	27.08207
P value for observed studies	0.000
Alpha	0.05
Orientation	2
Z value for alpha	1.95996
Number of observed work	94
FSN	7854

Table 6. Investigation of the effect of lessons taught using digital story applications on students' academic achievement according to the publication type moderator variable.

Type of publication	**N**	**Average effect size value (ES)**	**95% confidence interval for effect size**		**Standard error (SE)**	**Homogeneity value (Q)**	**df (Q)**	**p**	**.05 Confidence level X^2**
			Lower bound	**Upper bound**					
Article	36	0.733	0.599	0.867	0.068	0.062	1	0.803	3.841
Dissertation	58	0.760	0.592	0.929	0.086				

type of publication in which the studies are published. The joint effect sizes of the studies published in all types of publications are significant, and the results are in favor of the experimental group.

Secondly, it was examined whether the moderator variable of the academic level makes a significant difference and the related results are summarized in Table 7.

Table 7. Investigation of the effect of lessons taught using digital story applications on students' academic achievement according to the level of education moderator variable.

Level of education	N	Average effect size value (ES)	95% confidence interval for effect size		Standard error (SE)	Homogeneity value (Q)	df (Q)	p	.05 confidence level X^2
			Lower bound	Upper bound					
Kindergarten	6	0.982	0.591	1.373	0.199				
Primary school	27	0.493	0.342	0.644	0.077				
Middle school	42	0.902	0.708	1.095	0.099	15.166	4	0.004	9.488
High school	8	0.887	0.514	1.260	0.190				
University	11	0.556	0.281	0.830	0.140				

Table 8. Investigation of the effect of classes taught using digital story applications on students' academic achievement according to the course type moderator variable.

Course type	N	Average effect size value (ES)	95% confidence interval for effect size		Standard error (SE)	Homogeneity value (Q)	df (Q)	p	.05 Confidence level X^2
			Lower bound	Upper bound					
Mathematical/Statistical	30	1.085	0.826	1.344	0.132	12,414	1	0.000	3.841
Non-Mathematical	64	0.585	0.485	0.929	0.051				

Table 9. Investigation of the effect of lessons taught using digital story applications on students' academic achievement according to the moderator variable of study origin.

Study origin	N	Average effect size value (ES)	95% Confidence Interval for effect size		Standard error (SE)	Homogeneity value (Q)	df (Q)	p	.05 Confidence level X^2
			Lower bound	Upper bound					
Turkey	74	0.749	0.611	0.887	0.070	0.001	1	0.977	3.841
Foreign	20	0.746	0.559	0.932	0.095				

When Table 7 is examined, it has been determined that the moderator variable of the teaching level causes a significant difference on the effect size value ($p < .05$). In other words, the academic achievement of students in courses taught with the digital story method and students in courses taught with other teaching methods and techniques differ significantly according to the education level of the students. The kindergarten level has the highest joint effect size among all levels of education. It is followed by middle school, high school, university, and elementary school, respectively. The joint effect sizes in all levels of education are significant, and the results are in favor of the experimental group.

Third, whether the subject area moderator variable makes a significant difference was investigated, and the respective results are summarized in Table 8.

When Table 8 is examined, it was determined that the moderator variable of course type makes a significant difference on the effect size value ($p < .05$). In other words, the academic success of students in courses taught with the digital story method and students in courses taught with other teaching methods and techniques differs significantly according to the course type in which experimental operations are performed. While the course type with the highest joint effect size is mathematical field with 1,085, the effect size in the non-mathematical field is 0.585. In both course types, joint effect sizes are significant, and the results are in favor of the experimental group, where classes are taught with the digital story method.

Finally, it was examined whether the moderator variable study origin makes a significant difference, and the related results are summarized in Table 9.

When Table 9 is analyzed, it was determined that the moderator variable study of origin does not cause a significant difference on the effect size value ($p>.05$). In other words, the academic achievement of students in courses taught with the digital story method and students

in courses taught with other teaching methods and techniques do not significantly differ according to the place (Turkey/Foreign) where experimental operations were conducted. The joint effect sizes of the studies published in both study origin categories are significant, and the results are in favor of the experimental group.

CONCLUSION AND RECOMMENDATIONS

In this study, which investigates the effect of lessons taught with the digital story method on students' academic achievement, the effect size values of 94 studies within the scope of meta-analysis were calculated. It was determined that 91 of 94 studies included in the meta-analysis were positive and 3 were negative. This indicates that the digital story method makes a significant difference in favor of the experimental group. This result shows that the academic achievement of the students in the courses in which digital stories are taught is higher than the academic achievement of the students in the courses taught compared to other teaching methods (used in research included in the meta-analysis). This shows that the lessons taught using the digital story method create a much more positive learning and teaching process than other teaching methods (used in research included in the meta-analysis).

Since there is heterogeneity among individual studies included in the meta-analysis, the effect size value was calculated according to the random effects model and the average effect size value of 94 studies was calculated as +0.750. This value indicates a wide (high) effect when interpreted according to Cohen et al. (2011). From this point of view, it can be said that digital story method has a high level of influence on students' academic achievement compared to other methods used in the studies examined within the scope of the research. The positive aspect of the effect size value shows that this high level effect is in favor of the students in the experimental group.

When the distribution of the studies included in the meta-analysis within the scope of the study in the funnel plot is examined, it was observed that vast majority of the studies were clustered inside the funnel as well as on the ends. This indicates that the studies included in the meta-analysis have a high contribution to the calculated joint effect size. However, it should be noted that there are studies in the funnel plot that distort the symmetrical appearance. This situation indicates that some research may create publication bias. For this reason, calculations have been made using various formulas to determine whether the meta-analysis has publication bias, and the obtained results have revealed that the meta-analysis is resistant to bias.

In the research, the type of publication, teaching level, course type, and study origin variables were determined as moderator variables. Differences in academic achievement of students who took part in educational processes using digital story and other teaching methods were analyzed in accordance with these four different moderator variables. According to the obtained results, the course type and teaching level variables made a significant difference on effect sizes of the studies, the type of publication and study origin variables did not make a significant difference.

The fact that the digital story method, which is suitable for modern education systems due to the nature of its structure, has a high and positive effect on students' academic achievement shows that this method is applicable in educational activities. It is obvious that digital story activities, which are supported and enriched with other methods and techniques, will yield much more effective results on students' academic achievement.

The digital story method has been one of the most researched topics in the last 20 years. However, when the literature is examined, meta-analysis studies investigating the general effect of the use of digital stories on students' academic achievements have not been found. By conducting other studies such as this study, which can overcome this shortcoming in the literature to some extent, different effects of the use of digital stories on different variables of educational activities can be determined. However, when the literature is analyzed, very few meta-analysis studies are encountered that technology-based methods such as digital story have positive effects on students' academic achievement. For example, Yılmaz and Batdı (2016) concluded in their study, where they examined the effect of augmented reality method on students' academic achievement using meta-analysis, that augmented reality applications positively affect students 'academic achievement, even at a small level. In their study published in 2019, Küçük Avcı et al. analyzed the effect of three-dimensional virtual environments and augmented reality applications on learning success with meta-analysis. As a result of their study, the researchers stated that 3D virtual environments and augmented reality applications have a moderate and positive effect on learning success. Another meta-analysis study carried out in this context was published by Özdemir et al. in 2018. At the end of the study, which focuses on the effects of augmented reality applications on students 'academic achievement, it is concluded that augmented reality applications increase students' academic achievements compared to traditional teaching in the learning process. While all these meta-analysis studies in the literature overlap with the results of this meta-analysis study, it is meaningful in terms of demonstrating that technology-based activities such as digital stories are effective in increasing students' academic achievement.

Research results show that the use of digital stories increases students' academic success in many different course types. For this reason, students should be supported to learn by including digital story activities in

different education programs.

The teacher's guidance is critical to achieve the desired results from the digital story method. Therefore, teachers, who are the leading actors of the teaching and learning process, should be sufficiently equipped regarding the digital story. In this context, existing teachers should gain skills in digital story through training programs such as in-service training or courses. On the other hand, it should be ensured that prospective teachers receive the necessary training through courses where they can learn technology-based methods such as digital story and augmented reality in teacher training institutions.

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