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Meta-Analytic and Meta-Thematic Analysis of Digital Storytelling Method

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Abstract

The purpose of this study is to analyze the effect of the digital storytelling method on academic achievement and various variables by examining the method in terms of meta-analytic and meta-thematic aspects. Therefore, meta-analytic and meta-thematic dimensions were used together in the study. Within the context of the meta-analytic dimension of the research, the data obtained from 34 studies meeting the criteria of inclusion from various databases were analyzed using Comprehensive Meta-Analysis Software (CMA) to examine the effect of digital storytelling method on academic achievement. On the other hand, in the meta-thematic dimension performed to complete the obtained data, qualitative findings were obtained by quoting common codes and themes from the qualitative studies. In this context, the general characteristics of the digital storytelling method, their contributions to the cognitive dimension, and difficulties encountered during application were addressed. According to the results of the research, the digital storytelling method has been found to have a significant positive effect on academic achievement. The results of the meta-thematic assessments revealed that the digital storytelling method had an effect on making the students gain several 21st-century skills such as creative thinking, effective communication, and research skills, and it facilitated learning, provided permanence, and positively affected academic achievement. Time limitation, limited internet access, technological insufficiency, technical problems, lack of technical knowledge and skills, and lack of technical support are some of the problems faced during the implementation.

Keywords: Digital storytelling, effect size, meta-analysis, meta-thematic analysis

Dijital Öyküleme Yönteminin Meta-Analitik ve Meta-Tematik Analizi

Öz

Bu araştırmanın amacı dijital öyküleme yönteminin meta-analitik ve meta-tematik açıdan incelenerek akademik başarı ve farklı değişkenler üzerindeki etkisini incelemektir. Bu amaç doğrultusunda, çalışmada meta-analitik ve meta-tematik boyutlar birlikte kullanılmıştır. Araştırmanın meta-analiz boyutu kapsamında, dijital öyküleme yönteminin öğrenme başarısı üzerindeki etkisini incelemek amacıyla farklı veri tabanlarından dahil edilme kriterlerine uyan 34 çalışmanın verileri CMA programıyla analiz edilmiştir. Diğer yandan elde edilen verileri tamamlamak amaçlı yapılan meta-tematik boyutta ise nitel yönlü çalışmaların ortak kod ve temalarından alıntılar yapılarak nitel bulgulara ulaşılmıştır. Bu kapsamda dijital öyküleme yönteminin genel özellikleri, bilişsel boyuta katkıları ve uygulama esnasında karşılaşılan güçlüklere değinilmiştir. Araştırma sonuçlarına göre, dijital öyküleme yönteminin öğrenme başarısı üzerinde olumlu ve anlamlı bir etkisinin olduğu görülmüştür. Yapılan meta-tematik değerlendirmeler sonucunda dijital öyküleme yönteminin öğrencilerin yaratıcı düşünme, etkili iletişim ve araştırma becerileri gibi 21.yy becerilerin kazandırılmasında etkili olduğu, öğrenmeyi kolaylaştırdığı, kalıcılığı sağladığı ve akademik başarısını pozitif yönde etki ettiği anlaşılmıştır. Zaman darlığı, sınırlı internet erişimi, teknolojik açıdan yaşanan yetersizlikler, teknik sorunlar, teknik bilgi ve beceri eksikliği, teknik destek eksikliği uygulama esnasında yaşanan problemler arasında yer almaktadır.

Anahtar kelimeler: Dijital öyküleme, etki büyüklüğü, meta-analiz, meta-tematik analiz

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1 | INTRODUCTION

Developments in electronic and digital fields and changes in student profiles bring along the use of new methods and techniques in education. Today's methods and techniques used to differentiate, support, and enrich education provide the opportunity for effective, quality, and permanent learning as well as structuring the knowledge. Therefore, there is a transition from traditional teaching methods, where paper and pencil are used, to contemporary teaching methods, where computer and Internet technologies are utilized. One of these learning methods is the digital storytelling method which has replaced traditional storytelling. This method, which allows creating stories in the digital environment, involves skills of creating stories and using technology as well as using the stories for pedagogical purposes in the classroom environment (Meadows, 2003; Smeda, Dakich & Sharda, 2012).

In digital storytelling, which spreads far and wide today and adds a new dimension to traditional storytelling, mostly visual images containing multimedia applications are used instead of verbal images (Sayılgan, 2014). Digital storytelling can be defined as a short (2-3 minute) video-narrative created by gathering multimedia elements such as text, sound, graphics, animation, still and animated imagery to inform the audience about a certain subject (Robin, 2006). While Wang and Zhan (2010) define digital storytelling as a modern version of the art of traditional storytelling, Armstrong (2003) defines it as information transfer or sharing storytelling through media. Although there are different definitions of digital storytelling in the literature, the common point of these definitions is the enrichment of the art of storytelling with various multimedia elements such as images, sound, text, and video (Robin, 2006).

The digital storytelling process in teaching environments is composed of four main phases: "(1) pre-production, (2) production, (3) post-production, and (4) distribution". In the first phase, the story's main focus and topic are determined, and ideas are created about the elements of the story. In this phase, multimedia materials and contents are created for the story/scenario. In the next phase, scenarios and images are transferred into the digital media. Animated images are produced and dubbing of the story is performed in the virtual environment using the selected computer software. In the third phase, the fragments are put together to unify. Peer review and expert assessment techniques are used to get feedback and obtain different perspectives on digital storytelling created, and necessary adjustments are made accordingly. In the final phase, digital stories are shared and presented to get contributions and comments (Demirer, 2013; Kearney, 2011; Kocaman-Karoğlu, 2016). Besides, seven key elements should be taken into consideration for creating an effective digital story (Büyükcengiz, 2017; Robin, 2006). These elements are shown in Table 1.

Table 1. The Seven Elements of Digital Storytelling

Point of View	Identifying the main point of the story and the perspective of the author.
A Dramatic Question	A key question that keeps the viewer's attention until the end of the story.
Emotional content	Identifying an issue that connects the viewer to the story in an emotional manner.
Emotional Content	Impressive and fluent dubbing that makes the story easy to understand.
The Power of the Soundtrack	Using music or sound effects that support and embellish the main theme of the story.
Economy	Using just enough content to tell the story without overloading the viewer.
Pacing (Rhythm)	The progress of the story in a natural rhythm and tempo.

We could group digital stories into three different categories (Robin, 2006). The first one is personal narratives. In this type of storytelling, the narrator shares significant incidents in his/her life. Stories shared on social media could be examples of this type. The second category is historical documentaries that focus on historical events. These documentaries, which are told as documentaries, are stories investigating past

events that would help us better understand the history. The third one is instructive and informative narratives on a particular concept or practice. This type of storytelling is usually used in education.

According to the studies in the literature, it could be seen that digital stories are used in two different ways in education (Gils, 2005; Büyükcengiz, 2017). In the first one, the students share their own digital stories that they have created in the classroom environment under the teacher's guidance, while the teachers present digital stories, which they or others have created, to students in the second one. In the first case, the students are provided with training on how to create stories, and several examples are analyzed before they create their digital stories. These two categories could be further classified into two as the ones with the images created by the students, and the ones in which stock images are used (Balaman, 2017).

Digital storytelling has the characteristics of a source which supports educational practices by being integrated with the curricula at different levels from pre-school period to higher education. This method can be used as an effective tool in several disciplines and various courses such as teacher education, literacy instruction, literature, history, language skills (listening, speaking, reading, writing), health, and community practices (Dupain & Maguire, 2005; Sadik, 2008; Robin, 2006). Therefore, the inclusion of digital storytelling in curricula as a complementary and empowering tool may contribute to effective, meaningful, and permanent learning (Dakich, 2008).

The inclusion of digital storytelling in curricula has many contributions. The studies in the literature revealed that digital storytelling method improves student achievement and performance (Abiola, 2014; Francis, 2018; Hung et al., 2012; Ing, 2018; Kahraman, 2013; Liu et al., 2018; Yang & Wu, 2012), positively affects students' attitudes towards the course (Büyükcengiz, 2017; Çiçek, 2018; Demirer, 2013; Yang & Wu, 2012), has a positive effect on their interests and motivations (Aktaş & Yurt, 2017; Demirer, 2013; Doğan, 2007; Hung et al., 2012; Kahraman, 2013; Robin, 2006), and ensures the active participation of the students in the courses instead of being passive (Doğan, 2007; Howell & Howell, 2003; Gils, 2005; Raymond, 2008; Robin, 2006). Also, various studies state that it improves writing skills, critical thinking skills, problem-solving skills, and communication skills of the students (Baki, 2015; Doğan, 2007; Duman & Göçen, 2014; Foley, 2013; Gakhar, 2007; Hung et al., 2012; Robin, 2006; Yang & Wu, 2012). In the studies, it is also stated that this method is particularly effective in teaching boring, hard-to-understand, and complicated topics, concreting abstract concepts and facilitating the learning process and making it more comprehensible (Büyükcengiz, 2017; Kotluk & Kocakaya, 2017; Robin, 2008). Moreover, several studies have revealed that digital storytelling has been effective in acquiring 21st-century skills such as information literacy, visual literacy, technology literacy, creative thinking, effective communication, researching, and presentation (Jakes, 2006; Robin, 2006; Sadik, 2008; Yang & Wu, 2012). To conclude, the digital storytelling method, which is a student-centered approach, supports permanent learning by activating multiple senses such as hearing, seeing, and feeling (Turgut & Kışla, 2015).

Considering the studies in the literature generally, it is found out that both teachers and students face some problems while applying the digital storytelling method in classrooms. The most frequent problems that prevent the use of digital storytelling are lack of hardware and software, insufficiency of sources, insufficient technical support, and time limitation (Cuban, 2001; Dayan, 2017; Snoeyink & Ertmer, 2001). Besides, limited Internet access may prevent to access sources for the students, and it negatively reflects on the process of digital storytelling (Karakoyun, 2014). On the other hand, inadequate technology skills of teachers and students, their resistance to change, lack of interest, attitude, and motivation can be expressed as some other important problems encountered in the process of digital storytelling (Duhaney, 2001; Bauer & Kenton, 2005). Moreover, infringement of copyright and intellectual property rights by the students becomes prominent as a negative factor in the formation of digital storytelling (Bull & Kajder, 2004; Karakoyun, 2014). It can be stated that these problems should be eliminated to achieve the desired effect of digital storytelling studies.

The Purpose and Significance of the Study

Although there has been an increase in the number of studies on the effectiveness of the use of the digital storytelling method in the teaching environment in terms of different fields and sample groups in recent years, there is no comprehensive information that examines their results in a holistic approach. Therefore, it can be stated that there is a need for comprehensive and reliable high-level studies that can contribute to a holistic analysis of the results of these studies, to reach a general judgment, and to make the comments stronger. In light of this basic justification, the present study aims to reveal the general situation as a result of the two-dimensional (meta-analytic and meta-thematic) analysis of the digital storytelling method, which is rarely seen in the literature.

Meta-analysis studies on the effect of digital storytelling on students' academic achievement are limited in the literature. In this context, the meta-analysis dimension of the study was performed, and the results of previous studies on the subject were examined to reach a general judgment by presenting the existing knowledge. Unlike the studies that suggest that the digital storytelling is an effective approach to academic achievement in the literature (Abiola, 2014; Aktaş & Yurt, 2017; Büyükcengiz, 2017; Çiçek, 2018; Demirer, 2013; Francis, 2018; Göçen, 2014; Hung et al., 2012; Ing, 2018; Kahraman, 2013; Liu et al., 2018; Özerbaş & Öztürk, 2017; Yang & Wu, 2012); also several studies state that the method has no or low impact on academic achievement (Abdolmanafi-Rokni & Qarajeh, 2014; Nam, 2017; Özpinar, Gökçe & Yenmez, 2017). Therefore, added results of various studies on the effect of the digital storytelling method on academic achievement. It can be stated that conducting such a study is important to determine whether the digital storytelling method affects the academic achievement or not by aggregating independent empirical research, also, to determine its level to make more clear estimations and generalizations for the future, if it has. Furthermore, it can be stated that this study is important to aggregate the knowledge created by the existing studies, pioneer the future studies on the subject, and provide a reference.

On the other hand, a thematic dimension was added to the study to reveal the big picture to support and strengthen the meta-analysis dimension. It is thought that the extrapolated results will provide a comprehensive and general overview of digital storytelling method, also, the two-dimensional study will fill the academic gap and draw attention in related literature and encourage the researchers to conduct studies using multiple methods. It can also be stated that the present study, which has both qualitative and quantitative aspects, is different from other studies; thus, it has a unique characteristic. Since there are almost no multi-dimensional studies on the subject in literature, it is thought that the present study will be unique, shed light on future studies, and serve as a model. In the light of these basic justifications, this study aims to examine the effectiveness of digital storytelling method in terms of academic achievement using meta-analysis, and its impact on different dimensions using meta-thematic analysis. In line with this general purpose, the research seeks answers to the following questions:

1. What is the effect size of the digital storytelling method on academic achievement?
2. In terms of different education levels, what is the effect size of the digital storytelling method on academic achievement?
3. In terms of practice duration, what is the effect size of the digital storytelling method on academic achievement?
4. What is the effect size of the digital storytelling method on academic achievement in terms of course/subject areas?
5. How effective is the digital storytelling method in terms of thematic review based on document analysis?

2 | METHOD

In the present study, the effectiveness of the digital storytelling method on academic achievement, its cognitive contributions in the process of integration with education, general characteristics, and difficulties encountered during application were examined. In this respect, both quantitative and qualitative methods were used together to present a comprehensive perspective. In this part of the study, the type and design of the research, processes of collecting, coding, and analyzing the data are explained in detail.

In the quantitative dimension of the research, the meta-analysis method, which is a form of systematic synthesis methods, was used. The meta-analysis, which is a kind of synthesis of experimental studies, is a literature review method used to combine and reinterpret the results of individual studies on a specific subject (Cohen et al., 2002; Little et al., 2008). Although there are many literature review methods, what distinguishes the meta-analysis method from others is that it is a quantitative method based on statistical techniques and numerical data. The meta-analysis method was used in the present study because it aimed to examine the effect of digital storytelling on academic achievement and there was a need to make interpretations with a holistic approach and come to a conclusion by benefiting from available studies on the subject.

With the intent of making a more detailed search on the subject, expanding the scope of the study, and enriching the data set, the qualitative dimension (meta-thematic analysis) was added to complete and supplement the qualitative dimension (Batdı, 2017). In the meta-thematic analysis method, it is aimed to bring together the views of the respondents selected for qualitative studies related to the research subject (Batdı, 2017). From this point of view, a method which includes the process of revising the themes created from the opinions is in question. In the meta-thematic analysis process, the data obtained through document review were interpreted. Document review, which is one of the qualitative research methods, includes the analysis of written materials containing information about the case or cases aimed to be investigated (Yıldırım & Şimşek, 2013).

DATA COLLECTION

In this research, studies on digital storytelling method were searched in databases of Web of Science, ERIC (EBSCO), Wiley Online Library Full Collection, Science Direct, Taylor & Francis Online, Scopus (A&I), Springer LINK, Google Scholar, ProQuest Dissertation & Thesis Global, and Turkish Council of Higher Education Thesis Center. To reach the relevant studies, the following terms were searched as keywords in databases:

(i) terms related to the digital environment (i.e., digital, computer, mobile, tablets, technology, etc.);

(ii) terms related to storytelling (i.e., story, stories, storytelling, story telling, narrative, etc.);

(iii) terms related to academic achievement (i.e., achievement, success, gains, performance, learning outcomes, etc.).

In this research, studies in Turkish and English were chosen. As it was aimed to reach all studies on the impact of the digital storytelling method on academic achievement in the research, no time filter was used. The screening process was carried out between December 2019 and March 2020, and the complementary search was made in July 2020. In the search results, M.Sc. and Ph.D. theses and articles published in peer-reviewed journals were included in the analysis. Besides, attention was paid to include experimentally designed studies with control groups in meta-analysis so that the standard effect size would be calculated. In the studies that will be included in the meta-analysis, the independent variable is the digital storytelling method and the dependent variable is the studies on academic achievement. The studies that did not meet the inclusion criteria and those that did not have sufficient data to calculate the effect size were left out of the scope of the research. The PRISMA flow diagram (Moher, Liberati, Tetzlaff, Altman, & Prisma Group,

2010) showing the process of obtaining the studies included in meta-analysis during the literature review stage is given in Figure 1.

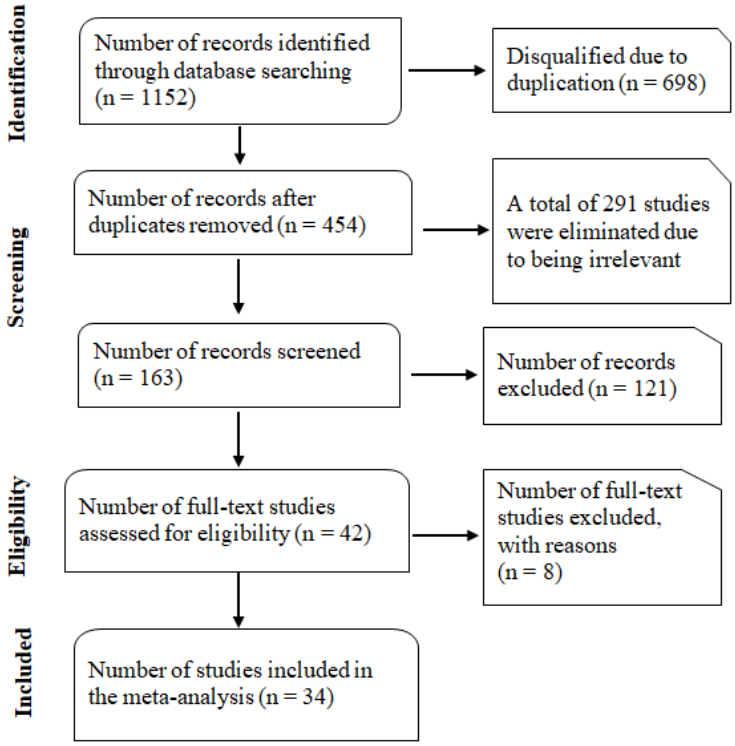

Figure 1. *Flow Chart for Selection of Studies*

Examining Figure 1, it is seen that a wide range of publications (n=1152) addressing the impact of the digital storytelling method on achievement was reached at the end of first searches on the databases. Relevant filters were applied to these publications, and the scope of the research was narrowed down. After the implementation of search criteria, 698 of these studies were excluded as they were duplicates, and 291 of them were excluded after reading their abstracts and understanding that their titles were irrelevant. In the end, 163 studies were included in the study. Upon examining these studies within the context of inclusion criteria, 121 of them were eliminated. When the remaining 42 studies were evaluated in terms of suitability and quality, eight studies that did not contain a sufficient amount of data (n=3) and were of poor quality (n=5) were also excluded. Thus it was decided to include only 34 studies in meta-analysis. However, it was seen that four of the studies (Dinçer, 2019; Liu, Tai & Liu, 2018; Nnakwe, 2019; Tahriri et al., 2015) the variable of academic achievement was used for multiple subject areas at the same time. The study included 39 items from 34 studies. Therefore, the findings of these studies were meta-analyzed separately in line with the structure of the meta-analysis studies and included in the research as different studies, and the number of studies was expressed accordingly. Moreover, it was found out that the data required to calculate the effect size were missing in one of the studies included in the study (Göçen, 2014). The data was included in the analysis by contacting the author of this study.

Coding Process

Each study, which was reached after the literature review, needs to be coded to convert their descriptive data to quantitative data, to compare the studies, and to determine if the studies meet the inclusion criteria of meta-analysis. In this context, the studies included in the research were coded. At this stage, a coding form was created in line with the purpose of the research. The generated coding form consists of two parts. In the first part, descriptive details of the studies (study number, author(s), publication

year, the course in which the study was implemented, education level, and application period) were used as data. Sample size (n), average ($\bar{X}$), and standard deviation (sd) data of experimental and control groups were included in the second part to calculate the effect size of the studies. To test the reliability of the study, coding processes were cross-checked by two independent raters, erroneous coding and classification were eliminated, and the analysis was continued until consensus was reached between the raters.

Data Analysis

Examination dimensions in the research form were coded in detail using Microsoft Office Excel and converted into a table, and related findings were calculated by filtering the descriptive analyses. In this study, CMA software was used to apply the meta-analysis technique. Although the classification of effect size calculated as a meta-analysis unit varies, the effect sizes were assessed according to Cohen (1988). According to Cohen (1988), the effect sizes between 0.2-0.5 are considered small, effect sizes between 0.5-0.8 are considered medium, and effect sizes equal to 0.8 and above are considered large. It is not possible to say that the studies conducted by different researchers to determine the effectiveness of the digital storytelling method on achievement have measured the same widespread impact. Therefore, it is inevitable for the studies included in the analysis to cause diversity among the results as they were conducted under different conditions. Therefore, Random Effects Model (REM) was used in this study to calculate the overall effect size. Moreover, the values revealed according to Fixed Effects Model are given in the findings. "Inter-Rater Reliability Level Formula" [consensus / (consensus + disagreement) x 100] (Miles & Huberman, 1994) was used to figure out the reliability of the research. According to the results of the calculations, the reliability of the research was found to be 100%, and this value indicates that the coding process was reliable.

In the qualitative dimension of the research which was based on a thematic examination, the reviewed qualitative studies on digital storytelling (n=8) were analyzed using QSR NVivo 8.0 software. The content analysis method was used to analyze the data. In fact, the content analysis aims to aggregate oral or written data which resemble each other and present an understandable study for the readers (Yıldırım & Şimşek, 2013). In this context, it was decided that content analysis is the most suitable method for this study to obtain similar/common results from studies conducted on the use of digital storytelling method in education. Similar/common themes and codes in previous studies conducted on the present subject were rearranged within a certain harmony and order and qualitative findings were obtained in this study. Then these findings were presented as models. Moreover, when the expressions in the studies on themes and codes were presented, they were cited in the text for support, justification, and most importantly, to ensure reliability. While these citations were presented, they were obtained from the relevant studies without making any changes in the expressions. The direct citations are indicated with the code of the related study and page number (e.g.: statement 471776-P.66; page 66 of study no. 471776).

Inter-rater agreement values (Cohen's Kappa) were used to ensure validity and reliability in the qualitative dimension of the study, (Viera & Garrett, 2005). In the present study, it was seen that the compliance value varied in the range of between 0.71 and 0.82. As these values were in the range of "good/very good compliance" according to Viera and Garrett (2005), they support the reliability of coding.

3 | Results

This section presents the data obtained as a result of meta-analytic and meta-thematic analyses of the examined studies. In this context, firstly, the results of the meta-analytic impact analysis of the studies on the impact of the digital storytelling method on academic achievement are presented. Then the meta-thematic findings related to the use of the digital storytelling method in education are provided.

Descriptive Statistics of the Studies

Descriptions examined in this research consist of educational level, application period, type of publication, publication year, subject area, and sample size. Descriptive data related to these variables are presented in Table 2.

Table 2. Descriptive Data of the Studies Included in Meta-Analysis

Variable	k	%	Variable	k	%
Duration of Application (Weeks)			Publication Year		
≤5	14	35.90	2012-2014	6	15.38
6-9	14	35.90	2015-2017	9	23.08
≥10	11	28.21	2018-2020	24	61.54
Education Level			Course/Subject		
Primary School	5	12.82	Science	12	30.77
Secondary School	22	56.41	Mathematics	4	10.26
High School	6	15.38	Social Sciences	4	10.26
University	5	12.82	Language Education	17	43.59
Other	1	2.56	Computer	2	5.13
Publication Type			Sample Size		
Article	18	46.15	Small Sample (n≤50)	17	43.59
M.Sc. Thesis	11	28.21	Medium Sample (51≤n≤100)	17	43.59
Ph.D. Thesis	10	25.64	Large Sample (n≥101)	5	12.82

Examining Table 2, it is seen that the majority of the 39 studies included in the meta-analysis were conducted in secondary schools (56.41%); and the least number of studies were conducted in university and primary schools. Eighteen of the studies (46.15%) included in the research were articles, 10 of them (25.64%) were Ph.D. theses, and 11 of them (28.21%) were M.Sc. theses. Six of the studies (15.38%) were conducted between the years of 2012-2014, and nine of them (23.08%) were conducted between 2015-2017. According to the sample sizes, it is seen that 17 studies (43.59%) were based on small samples, 17 (43.59%) were based on medium samples, and five (12.82%) were based on large samples. Finally, it was observed that most of the studies were conducted in the field of Language Education (43.59%), 12 studies (30.77%) were conducted in Science, and the least number of studies were conducted in the field of Computer.

Findings Regarding the Effect Sizes of the Studies on Academic Achievement

The average effect size values of the studies included in the analysis are presented in Table 3.

Table 3. The Homogeneous Distribution Value, Mean Effect Size, and Confidence Intervals of the Studies Included in the Meta-Analysis According to the Effect Models

Type of Model	k	Z	p	Q	df	ES	SE	% 95 CI	
								Lower	Upper
Fixed Effects	39	15.967	0.000	214.747	38	0.682	0.043	0.599	0.766
Random Effects	39	7.525	0.000	40.778	38	0.775	0.103	0.573	0.977

Note. k = number of effect sizes; df = degrees of freedom; ES = Effect Size; SE = standard error; CI = confidence of interval for the average value of ES.

As shown in Table 3, the results of the meta-analysis based on the Fixed Effects Model indicated that the upper limit of 95% confidence interval was 0.766, the lower limit was 0.599 and the average effect size was 0.682. At the end of the homogeneity test, the Q-statistical value was calculated to be 214.747. According to the Random Effects Model, it is seen that the value of the average effect size was calculated as 0.775, where the lower and upper bounds of the range were 0.573 and 0.977, respectively, with a standard error of 0.103 and a confidence interval of 95%. When the statistical significance of this effect size was calculated according to Z-Test, it was found to be 7.525 (p=0.000). When the findings of the research are interpreted according to Cohen (1988), it can be stated that the digital storytelling method has a medium effect on increasing academic achievement.

To ensure reliability in meta-analysis studies, dissemination bias status was examined. In this context, the Funnel Plot is given in Figure 2 for determining whether there is a bias or not in favor of the studies that have significant differences among the studies included in the research.

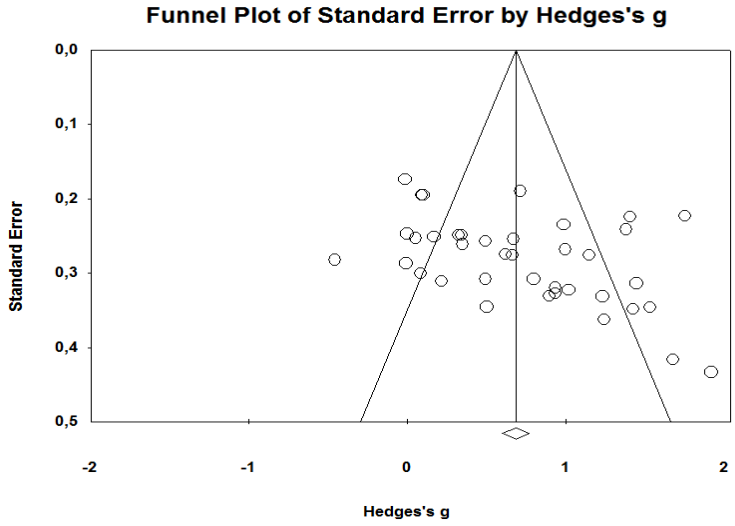

Figure 2. *Funnel Plot*

When Figure 2 is examined, it is understood that the studies do not show an asymmetric distribution around the overall effect size. In other words, distribution is not concentrated on one side. The fact that the distribution does not form an asymmetric accumulation at a single point means that the study sample is not biased in favor of the digital storytelling method, and this meta-analysis study is reliable. The Rosenthal FSN value was also calculated to support the finding obtained from the funnel plot. The findings are given in Table 4.

Table 4. Rosenthal's Fail-Safe Number Calculations

Z-value for observed studies	16.94270
p-value for observed studies	0.00000*
Alfa	0.05000
Tails	2
Z for alpha	1.95996
Number of observed studies	39
Fail-safe N	2876

*Note. *p < .05*

Examining Table 4, it is seen that the safe N number is 2876. In other words, it can be stated that if the study with a negative or neutral difference as much as the number in this value is included in the analysis, the significant effect may decrease to zero. Comparing the number of studies included in the analysis with

the FSN value, it is understood that the FSN value is quite high and unreachable. This information shows that the meta-analysis results are reliable.

Effect Sizes of the Studies According to Moderators

According to the results of the study, it was observed that studies included in the present study had different education levels, course/subject areas, and application durations. Therefore, it was desired to investigate whether the effect size of the digital storytelling method on academic achievement varies by the education level, subject area, and duration of application. Moderator analysis results of studies included in the meta-analysis are presented in Table 5.

Table 5. The overall effect sizes of the studies according to moderator analyses.

	Variables	N	ES	% 95 CI		QB	Z	df	p
				Lower	Upper				
Education Level	Primary School	5	0.714	0.397	1.031	15.885	10.686	4	0.003
	Secondary School	22	0.662	0.376	0.949				
	High School	6	1.302	1.008	1.596				
	University	5	0.865	0.397	1.334				
	Other	1	0.323	-0.164	0.811				
	Sum	39	0.837	0.683	0.990				
Course/ Subject	Computer	2	0.697	-0.663	2.056	22.609	6.715	4	0.000
	Language Education	17	0.776	0.462	1.089				
	Science	12	0.944	0.536	1.352				
	Mathematics	4	0.142	-0.080	0.363				
	Social Sciences	4	0.977	0.560	1.395				
	Sum	39	0.523	0.371	0.676				
Duration of Application	≤5	14	0.470	0.185	0.755	5.937	7.482	2	0.051
	6-9	14	1.016	0.635	1.397				
	≥10	11	0.862	0.518	1.206				
	Sum	39	0.726	0.535	0.916				

According to Table 5, when the inter-group homogeneity test was analyzed by *education levels*, Q_B was found to be 15.885. Since the value of Q_B (15.885) was observed to be larger than the critical value of $\chi 2$ distribution with degrees of freedom of 4, it could be said that the distribution was heterogeneous ($\chi 2_{(0.95)}$= 9.488). Also, it could be said that the overall effect size of education levels (ES=0.837) was large in terms of Cohen's (1988) classification. According to these results, the effect of the digital storytelling method on academic success varies by education levels (p=0.003).

When the intergroup homogeneity test was analyzed by course/*subject areas*, Q_B was found to be 22.609. Therefore, since the statistical value of Q_B (22.609) was larger than the $\chi 2$ value ($\chi 2_{(0.95)}$=9.488), it could be said that the distribution between effect sizes was heterogeneous. It was then concluded that the overall effect size was found to be ES=0.523 and that this value regarded as medium according to Cohen (1988). On the other hand, it can be also said that the effect of the digital storytelling method on academic achievement differs across course/subject areas (p=0.000).

When the *duration of the application* of studies was analyzed, Q_B value was found to be 5.937. Therefore, the statistical value of Q_B was found to be smaller than the $\chi 2$ value ($\chi 2_{(0.95)}$=5.991). In this case, it could be stated that the distribution of effect sizes was homogeneous and the effect of the digital

storytelling method on academic achievement did not differ by the duration of application (p=0.051). Hence, the level of academic achievement was found to be independent of the duration of the application in classes in which the digital storytelling method was used. On the other hand, the overall effect size value was found to be ES=0.726, and this value was regarded as medium according to Cohen (1988).

FINDINGS REGARDING THE EFFECTIVENESS OF DIGITAL STORYTELLING METHOD WITHIN THE SCOPE OF THEMATIC ANALYSIS

In this section of the study, themes, and codes obtained from the meta-thematic analysis are presented to support the meta-analytic findings and provide enriched data for the study. Direct citations were included in the text to support the thematic data presented in different shapes and models. The thematic data obtained via comprehensive analyses were grouped and visualized under different themes in three models. The models addressing the contribution of the digital storytelling method to the cognitive dimension (Figure 3), its general characteristics (Figure 4), and the difficulties encountered during the application (Figure 5) are presented below.

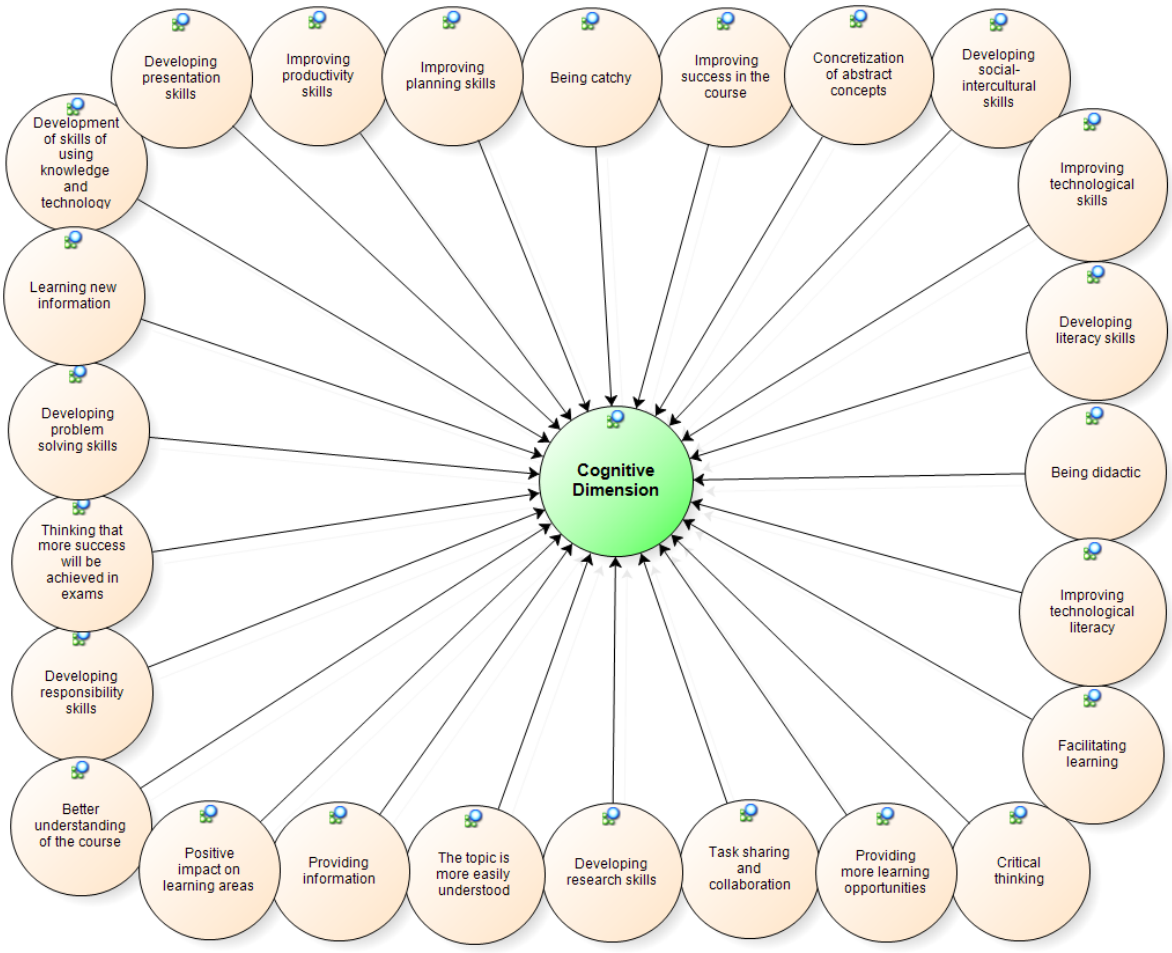

Figure 3. *Contribution of Digital Storytelling Method to Cognitive Dimension*

In Figure 3, some of the codes mentioned in the context of the contributions of the digital storytelling method to cognitive dimension are specified as "improving productivity, planning, problem-solving, and critical thinking skills; being catchy; concreting abstract concepts and being instructional". Within the context of this theme, the cited topic from the study coded 328704-S.237 "*allows us to repeat the topic. The repetition of the topic enables us to understand better. We also benefit visually. What we learn becomes more permanent…*" and the statement in the study coded 361705-S.125 "*I liked it very much because learning*

new things in the digital environment has improved me a lot. Most of it was an informative video. I believe I've learned new things from most of them. Even a friend of mine had done something on time travel. I have found it very interesting. I watched them and learned new things" statements were used as reference sentences and used in the formation of codes.

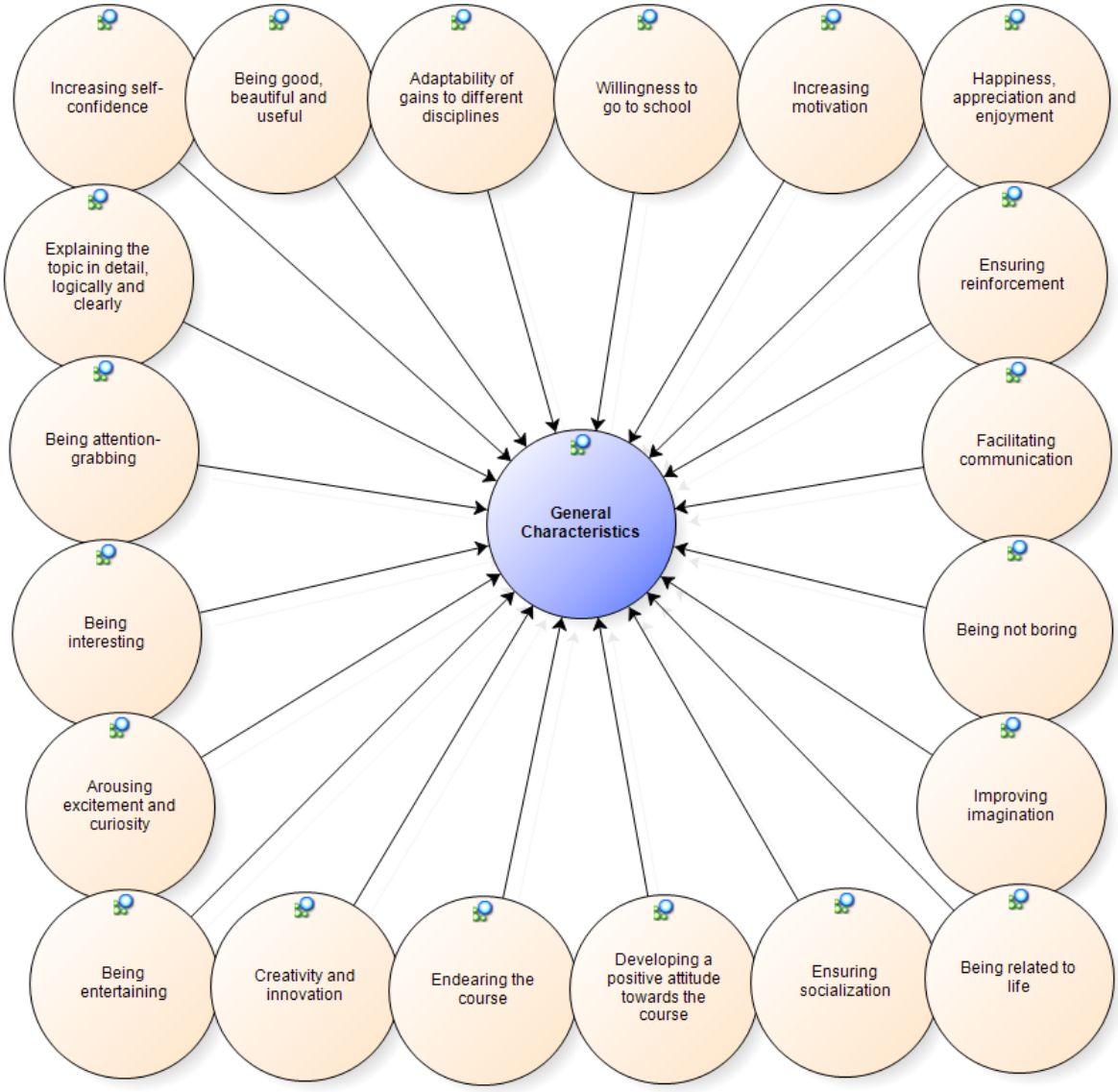

Figure 4. *General Characteristics of Digital Storytelling Method*

When Figure 4 is examined, it is understood that the codes about the general characteristics of the digital storytelling method were created. Some of the codes related to this model can be expressed as "being interesting and entertaining; improving communication, participation, self-confidence, and motivation; being associated with life; ensuring socialization and reinforcement". Some expressions used as a reference to create the related codes were cited from the study coded 471776-S.66 are "*Our normal science classes were boring. Courses were very hard. They were not entertaining. I was having difficulty understanding the course. But now we shoot movies about the course in groups and our lessons have become more entertaining with digital storytelling*", or the expression cited from the study coded 352043-S.93 can be stated as: "*Using digital storytelling enables us to understand the course and associate it with life.*" The

sentences found in the study coded 328704-S.224 states that "*It has improved my imagination... For example, I can do different things on different photos. I consider how I can make it better.*" can be specified as the sentences used as a base when creating the codes.

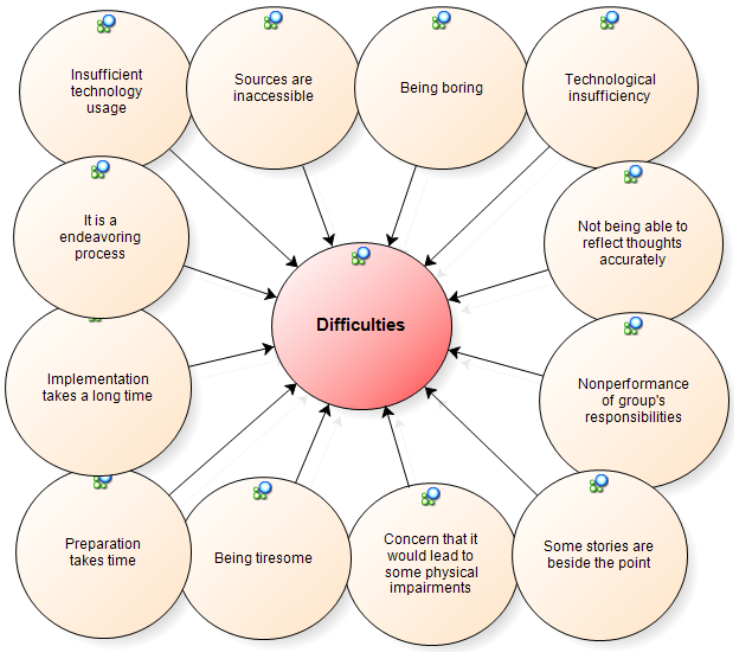

Figure 5. *Difficulties Encountered During Implementation*

It is seen that the difficulties and limitations encountered in the implementation of the digital storytelling method are expressed in Figure 5. Some of the prominent codes can be stated as "technical problems, insufficient usage of technology, time limitations, inaccessible sources, and being tiresome and hard process". Related codes such as "*Preparation takes time.*" (471776-S.67); "*... If you ask me, what I don't like about it is that it is tiresome. And sometimes the website can be very slow due to Internet connection ...*" (328704 -S.218) were created based on the above statements.

4 | Discussion & Conclusion

This research includes meta-analytic and meta-thematic assessments concerning the utilization of the digital storytelling method in educational environments. In this context, 34 studies were included in the meta-analysis and eight studies were included in meta-thematic assessments in line with the purpose of the research. Within the scope of the research, the data of the studies included in the meta-analysis were primarily examined. In conclusion, it was understood that studies generally focused on secondary schools, published articles, and language teaching. Besides, it was concluded that the number of studies increased after 2018, and those studies focused on practices that lasted for one or two months.

When the findings of the meta-analysis are examined, it was determined that the digital storytelling method has a positive and medium effect on academic achievement (ES=0.775). This result indicates that the digital storytelling method affects the improvement of the academic achievement of students. It also indicates that the digital storytelling method has a more positive effect on students' academic achievement compared to the teaching method stated in the curriculum. In fact, many studies in the literature reveal that digital storytelling method has a positive effect on academic achievement of students (Abiola, 2014; Aktaş & Yurt, 2017; Büyükcengiz, 2017; Çiçek, 2018; Demirer, 2013; Francis, 2018; Göçen, 2014; Hung et al., 2012; Ing, 2018; Kahraman, 2013; Liu et al., 2018; Özerbaş & Öztürk, 2017; Yang & Wu, 2012). In this case, it can be stated that the conclusion of the study is consistent with the related literature, and the said method improves the academic achievement of students. Within this context, the reasons why digital

storytelling method positively affects the academic achievement of students can be explained as follows; it is a student-centered approach (Bromberg et al., 2013), it is associated with life (Kahraman, 2013), it enables students to have an active role in the learning process, it attracts interest and attention of students and improves their motivation (Robin, 2006). Moreover, in this method where the technology is utilized effectively in adding images to written texts (Demirer, 2013), concretizing of abstract concepts, and thus, making the lesson more apprehensible (Büyükcengiz, 2017; Robin, 2008) can be regarded as reasons of improvement in the achievement. On the other hand, some studies have revealed that there is no significant difference between the digital storytelling method and traditional teaching methods in terms of academic achievement (Abdolmanafi-Rokni & Qarajeh, 2014; Nam, 2017; Özpinar et al., 2017).

According to the results of the funnel chart and publication bias tests, it was found that there was no publication bias on calculating the overall effect size. This information demonstrates that the meta-analysis results are reliable. Besides, the moderator analysis was used to see whether the effectiveness of the digital storytelling method on students' academic achievement differed by education levels, subject areas, and the duration of the application. The relevant results demonstrate that the effectiveness of the digital storytelling method on students' academic achievement differed by education levels and subject areas; however, it did not differ by the duration of the application. The study sample is composed of 2371 participants.

Meta-thematic analyses were carried out along with meta-analysis in the research, and various themes and codes were generated regarding the impact of the digital storytelling method on different dimensions. At this point, firstly, the theme of contribution of the digital storytelling method to the cognitive dimension was created in support of the academic achievement specified in meta-analysis. When the codes mentioned under this theme were evaluated, it was found that digital storytelling method improved some 21st-century skills such as reasoning, creative thinking, productivity, critical thinking, effective communication, and problem-solving (Jakes & Brennan, 2005; Hung et al., 2012; Yang & Wu, 2012). It is concluded that this method, which enables effective use of technology in the classroom environment, is also effective in acquiring skills such as digital literacy, visual literacy, global literacy, media literacy, technology, and information literacy (Jakes, 2006; Robin, 2008). Also, it can be stated that it facilitates learning by making the hard-to-understand and boring topics easier and interesting and concretizing abstract topics (Büyükcengiz, 2017; Robin, 2008). Some studies in the literature are concluded that the method supports permanent learning by activating more than one senses, provides more learning opportunities, enables the students to understand the lesson better; thus, it positively affects their performance in the course (Turgut & Kışla, 2015; Aktaş & Yurt, 2017; Tecnam, 2013; Francis, 2018). On the other hand, considering the codes under the heading of "general characteristics and contributions of digital storytelling method", it was determined that the method positively affected the motivation for learning, participation in the lessons, and the attitude towards the course; thus, it provides a more enjoyable and entertaining learning-teaching experience in the classroom (Demirer, 2013; Robin, 2008; Yang & Wu, 2012). It also attracts the attention of students by addressing different senses organs along with arousing excitement and curiosity and contributes to the development of imagination and creativity concerning knowledge, ideas, and new products (Demirer, 2013; Kahraman, 2013; Tunç & Karadağ, 2013). It is considered that the digital storytelling method positively affects the willingness of students to like the course and attend the school as it explains the topic in detail, logically, and clearly, associates it with life and ensures socialization (Dayan, 2017; Kahraman, 2013; Özpinar et al., 2017). Due to all these positive aspects, the digital storytelling method provides an enriched learning experience to students and prevents them from getting bored by attracting attention to the course (Ayvaz Tunç, 2016; Büyükcengiz, 2017). Besides these contributions of the digital storytelling method to education, it was also determined that it has some difficulties and limitations. Technological insufficiency such as hardware deficiency and insufficient sources experienced in the digital storytelling method, technical problems encountered during its implementation such as limited Internet access are among the problems mentioned frequently in terms

of integration with technology (Demirer, 2013; Dayan, 2017; Karakoyun, 2014). Another important problem encountered in the process of digital storytelling is that the method is demanding and difficult and preparation takes a long time (Büyükcengiz, 2017; Snoeyink & Ertmer, 2001). Besides, some of the other negative aspects of the method can be stated as the teachers don't have enough knowledge about the method, they are insufficient in the utilization of technology, and the students cannot reflect their thoughts totally (Ayvaz Tunç, 2016; Kaya, 2014).

To implement the digital storytelling method effectively in schools, such problems should be solved. In this context, it is very important to enable the students to have access to the Internet, technological devices such as tablets, computers, and sources (Robin, 2006). Otherwise, technological insufficiency will make the implementation of the method difficult, and this will lead to significant inconveniences. It can also be suggested that the skills of students and teachers to utilize these technological devices and the software products required for the implementation should be taken into consideration, and necessary training should be provided (Coghlan, 2004; Lai & Kritsonis, 2006; Lin & Lu, 2012; Schwab & Foa, 2001). It can be stated that technical support can be provided to students to eliminate problems such as technical ones, and this would enable them to overcome such problems; thus, it improves the effectiveness of the method. Besides, the students may pay attention to lessons without getting bored by providing reinforcement to them and directing them to their areas of interest (Karakoyun, 2014). It is considered that the guidance of teachers would be helpful to direct the students to the phases of storytelling and keep them active in the learning process in order not to diminish the success of implementation (Woodhouse, 2008). It is also stated in the literature that digital storytelling should be short, plain, and apprehensible (Gregori-Signes, 2014; Kearney, 2011; Clarke & Adam, 2011; Boase, 2008).

This study is limited to query terms and scientific studies on the effect of the digital storytelling method on academic achievement carried out between 2011-2020. Besides, the study is limited to analyses of coded moderator variables. Studies compiled in the present study are limited to M.Sc. and Ph.D. theses and articles published in peer-reviewed journals only in English and Turkish. The study does not include studies published in other languages and other types of publications (such as book chapters and presentations). These findings and results could only be generalized if they are evaluated within the same context. Therefore, different research findings could be obtained by conducting more in-depth and comprehensive research.

The present study aimed to investigate the effectiveness of the digital storytelling method on academic achievement using meta-analysis and its effect on different dimensions using meta-thematic analysis. It is thought that research findings and results will be a good reference for researchers and instructors as well as contributing to the literature. In future studies, variables such as attitude, motivation, and permanence could be investigated, sub-group analyses could be conducted considering the duration of the application, sample size, age, and gender, and the practicality and effectiveness of the digital storytelling method could be analyzed in more detail. It has been observed that studies included in the meta-analysis generally focus on secondary school. The analysis could be repeated by including future studies focusing on other education levels. The analysis could also be repeated and compared by including the findings of new studies on the digital storytelling method to be carried out in the future. It is suggested that research techniques such as meta-analysis method, which allows combining and interpreting different findings from similar individual studies, should be used more in studies carried out today when information has been increasing rapidly

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