Trends of Game-Based Learning in Mathematics Education: A Systematic Review

Zeynep Bahar Erşen[1], Ebru Ergül[2]
[1]Selcuk University, 0000-0002-7928-2535
[2]Selcuk University, 0000-0002-0298-7035

To cite this article:

Trends of Game-Based Learning in Mathematics Education: A Systematic Review*

Zeynep Bahar Erşen[1], Ebru Ergül[1][**]
[1]Selcuk University

Abstract

Teaching mathematics through games is one of the most preferred methods in mathematics education today, just as it was in the past. For this reason, studies discussing the concepts of mathematics education and games are proceeding with increasing momentum. In this study, research studies conducted between 2017-2021 on games and mathematics teaching were analyzed using qualitative methods within the framework of certain criteria, and the trend shown by the studies was determined. In this way, a guide for future studies was also provided. For this reason, the study was conducted using a systematic review approach. Within the scope of the study, 80 research studies were examined. As a result of the research, it was seen that the most publications were made in 2019 and were of the article type, that studies aimed at determining effect gained importance, and that in the methodological context, quantitative studies were frequently preferred and experimental designs were used accordingly. It was also found that secondary school students were preferred as participants, that the most common type of game used was digital computer games, that the games were mostly associated with the learning area of "numbers and operations," and that the research studies had mostly positive results for the use of games in mathematics education.

Keywords: Game, Game based learning, Mathematics education, Systematic review

Introduction

Constructivism in education emerged after the behavioral approach as an approach that focuses on the active learner in the learning-teaching process, draws attention to the previous beliefs, knowledge and skills possessed by the individual, and reveals the pleasant and stimulating perspective of learning. However, constructivism's greatest contribution to education is the argument that knowledge as a product can be created through a process (Jones & Brader-Araje, 2002). In this regard, constructivist theory assumes that students in mathematics classrooms create mathematical knowledge themselves by going through a series of mental processes and using their prior knowledge. For example, while teaching division in a constructivist classroom environment, when you expect a student to answer the question, "How many groups of 5 can be made from the number 100?" the student should use the subtraction and multiplication operations from their previous knowledge. This is an indication of how the constructivist approach is reflected in mathematics teaching (Van de Walle, Karp & Bay-Williams, 2016). Along with this approach, Prince (2004) presented active learning as a model in which meaningful learning activities occur and students proceed by knowing what they are doing and how they are doing it. One method of teaching with games can be used in the student-centered active learning approach, where individual differences are taken into account and individuals can freely ask questions and discuss them.

The history of games is as old as human history itself. Almost every society in history has incorporated games into their daily lives (Wells, 2012). Moreover, from past to the present, mathematicians have created many games, such as Cardano's Rings (Chinese Rings), the Tower of Hanoi by Lucas, and the Hungarian Ernö Rubik's Cube (Uğurel & Moralı, 2008). In this respect, it is possible to say that there is a relationship between the game's concept and mathematics. Indeed, according to Foster (2004), the best way to involve students in mathematics activities is to allow them to make connections between games and their world. It is not easy to say how mathematical a game is (Silva, 2011); however, the mathematical game can be expressed as a type of

---

mathematical problem (Winicki-Landman, 2008). The mathematical game has a challenge, a set of rules, and specific mathematical cognitive goals (Oldfield, 1991). However, it should be ensured that students properly understand important issues such as the way a mathematical game should be played, the situation of the class and the design of relationships between students during the game, as well as the students' ability to understand the game and the duration of the game, and these issues should be properly explained (Usta et al., 2017).

When examining the studies that use the method of teaching with games, it was found that teaching with games increases academic achievement (Liang, Zhang, Long, Deng & Liu, 2019; Rawansyah, Pramudhita & Pramitarini, 2021; Rondina & Roble, 2019) and positively affects attitudes toward mathematics instruction (Chiang & Qin, 2018; Tuekle, 2020), and that research participants positively evaluate the use of games in mathematics instruction (Bragg, 2007; Koç-Deniz, 2019; Russo, Bragg & Russo, 2021; Watson-Huggins, 2018).Along with the increase in studies conducted on teaching mathematics with games in recent years, compilation studies are also encountered (Divjak & Tomić, 2011; Joung & Byun, 2020; Türker & Arslan, 2021). Divjak and Tomić (2011) analyzed 32 studies conducted between 1995 and 2010, in which an attempt was made to determine the effect of games on motivation and achievement of learning goals in mathematics education through the use of mathematical computer games. While the studies conducted in Turkey on teaching mathematics with games are discussed in the study made by Türker and Arslan (2021), content analysis is carried out for digital mathematical games in the 12th grade mathematics curriculum in the study by Joung and Byun (2020). Türker and Arslan (2021)' study was limited to between 2002-2017. When we examine it, we do not know the trend in the last five years. Hence, a new discourse is needed on this subject. Divjak and Tomić (2011) focused on mathematical computer games' effects on mathematic teaching. Their study didn't include educational games (card games, puzzles, board games, etc.) that affect in mathematics teaching. Joung and Byun (2020)' studies, on the other hand, contained limited to analysis based on NCTM standards. Since our study covers the years 2017-2021, it is more up-to-date than previous studies. In addition, mathematics education studies that contain both computer games and educational games are included in the research.

The number of systematic reviews has increased steadily in the last two decades, while there are significant benefits compared to conventional reviews in terms of examining all the available data (Bown & Sutton, 2010). In this study, it is thought that the systematic discussion of the recent studies on teaching mathematics with games on an international scale will guide the researchers who work in this field. In this context, this study aims to examine the research studies conducted between 2017-2021 on the use of games for mathematics education or teaching in terms of various variables. In line with the aim of the study, answers to the following research questions were sought:

- How are the conducted studies distributed in terms of type and years?
- What is the distribution of the studies carried out at national and international level?
- What are the purposes of the conducted studies?
- Which methodologies and designs are used in the conducted studies?
- How are the types and numbers of participants in the conducted studies distributed?
- What types and number of games were used in the studies conducted, and to what areas of learning do the games relate?
- What are the data collection tools, data analysis types, and validity and reliability methods used in the conducted studies?
- What do the results of the conducted studies reveal?

Method

Research Design

A research approach that comprehensively and in detail scans studies conducted using similar methods in a field, identifies studies to be included in the review using various selection criteria, and conducts a structured and comprehensive quality assessment of the identified studies and synthesis of their findings is referred to as a systematic review (Gough & Thomas, 2016; Higgins et al., 2019).A systematic review is the science of identifying, selecting and synthesising primary research studies in order to provide a comprehensive and reliable picture of the subject under examination (Oakley, 2012). As a form of research, systematic reviews bring together what is known in the research literature by using transparent and accountable methods (Cooper, Hedges & Valentine, 2019). In this way, the topics that need to be researched in the future and the gaps or areas that are insufficient in the literature can be identified. In this study, the research studies conducted between 2017-2021 on games and mathematics teaching were analysed with qualitative methods within the framework of certain

criteria. It was determined what kind of a trend the studies showed. In this way, a guide for future studies is also provided. For this reason, the study was conducted in accordance with the systematic review approach.

Data Collection Process

Data collection for the study lasted from October 10, 2021, to January 1, 2022. In the data collection stage of this study, the systematic review study criteria of Bown and Sutton (2010) were taken as reference. Accordingly, the subject of the study was determined as "the use of games in mathematics education". The keywords to include this subject were determined as "matematik ve oyun", "matematiksel oyun", "eğitsel matematik oyunları", "mathematics and game", "mathematical game", "math game", and "educational mathematics game". With these words, the "Google Scholar", "Wiley", "Eric", "Web of Science", "ASOS", "ULAKBİM", "SOBİAD", "YOK National Thesis Centre" and "ProQuest" databases were scanned by both researchers. As a result of this scan, 176 studies were accessed. These studies were examined according to the criteria that they were conducted between 2017 and 2021, were written in Turkish or English, were written by local or foreign authors, and related to the use of games in mathematics teaching or education. As a result of this examination, it was seen that there were 80 studies that met the criteria of the study to be conducted. Other studies were excluded because they did not meet the criteria of the study. The studies included in the scope of the research consist of 8 conference papers, 47 articles, 17 master's theses and 8 doctoral theses. The identifier and code information used in the analysis process according to the types of the examined studies are presented in Table 1.

Table 1. Identifier, type and code information of reviewed studies

Conference Papers	Codes
Ergül & Doğan (2019)	PT1
Er et al. (2019)	PT2
Yıldız-Durak (2019)	PT3
Üstün (2020)	PT4
Graceota & Slamet (2021)	PF5
Rawansyah, Pramudhita & Pramitarini (2021)	PF6
Shabrina et al. (2020)	PF7
Akintunde et al. (2020)	PF8
Articles	**Codes**
Usta et al. (2017)	AT1
Pilten, Pilten, Divrik & Divrik (2017)	AT2
Callaghan, Long, van Es, Reich & Rutherford (2017)	AF3
Barreto, Vasconcelos & Orey (2017)	AF4
Kalish (2017)	AF5
Turgut & Temur (2017)	AT6
Heshmati, Kersting & Sutton (2017)	AF7
Boz (2018)	AT8
Usta et al. (2018)	AT9
Aktaş, Bulut & Aktaş (2018)	AT10
Skillen, Berner & Seitz-Stein (2018)	AF11
Yong, Gates & Yee-Chan (2018)	AF12
Chiang & Qin (2018)	AF13
Fouze & Amit (2018)	AF14
Kiili, Ojansuu, Lindstedt & Ninaus (2018)	AF15
McFeetorsa & Palfy (2018)	AF16
Nfon (2018)	AF17
Çalışkan & Mandacı Şahin (2019)	AT18
Doğan & Sönmez (2019)	AT19
Özata & Coşkuntuncel (2019)	AT20
Rondina & Roble (2019)	AF21
Tärning & Silvervarg (2019)	AF22
Liang, Zhang, Long, Deng & Liu (2019)	AF23
Cohrssen & Niklas (2019)	AF24
Yıldız-Durak & Karaoğlan-Yılmaz (2019)	AT25
Saygı & Alkaş-Ulusoy (2019)	AT26
Machaba (2019)	AF27
White & McCoy (2019)	AF28
Ayvaz-Can (2020)	AT29

Gök (2020)	AT30
Gök, İnan & Akbayır (2020)	AT31
Yağmur (2020)	AT32
Deng, Wu, Chen & Peng (2020)	AF33
Bullock et al. (2020)	AF34
Başün & Doğan (2020)	AT35
Bui et al. (2020)	AF36
Es-Sajjade & Paas (2020)	AF37
Lee & Choi (2020)	AF38
Joung & Byun (2020)	AF39
Wouters & Van der Meulen (2020)	AF40
Taja-on (2021)	AF41
Russo, Brag & Russo (2021)	AF42
Dönme, Dönmez, Kolukısa & Yılmaz (2021)	AT43
Baran-Kaya & Gökçek (2021)	AT44
Türker & Arslan (2021)	AT45
Marange & Adendorff (2021)	AF46
Koneva & Shabanova (2021)	AF47
Master's Theses	**Codes**
Dönmez (2017)	MT1
Türkmen (2017)	MT2
Demirkaya (2017)	MT3
Atasay (2018)	MT4
Sönmez (2018)	MT5
Karamert (2019)	MT6
Çalışkan (2019)	MT7
Gülleci (2019)	MT8
Çubukluöz (2019)	MT9
Yılmaz (2019)	MT10
Galiç (2020)	MT11
Türker (2020)	MT12
Pehlivan (2020)	MT13
Tükle (2020)	MT14
Aksakal (2020)	MT15
Ergül (2021)	MT16
Başkahya (2021)	MT17
Doctoral Theses	**Codes**
Stanton (2017)	DTF1
Eyster (2017)	DTF2
Akkaya (2018)	DTT3
Watson-Huggins (2018)	DTF4
McIntosh (2018)	DTF5
Koç-Deniz (2019)	DTT6
Galarza (2019)	DTF7
Kokandy (2021)	DTF8

PT: Conference Papers with Turkish Authors, PF: Conference Papers with Foreign Authors, AT: Articles with Turkish Authors, AF: Articles with Foreign Authors; MT: Master's Theses with Turkish Authors, DTF: Doctoral Theses with Foreign Authors, DTT: Doctoral Theses with Turkish Authors.

Data Analysis

In this study, using Aztekin and Taşpınar-Şener (2015) as a reference, two content analysis methods were used together for the data analysis. After performing the descriptive and content analysis of the studies related to games and mathematics education, thematic analysis was carried out to interpret and synthesise the studies in depth (Çalık & Sözbilir, 2014). For this purpose, a thematic analysis matrix was created by the researchers. The data analysis systematics used in the meta-synthesis studies made by Aztekin and Taşpınar-Şener (2015), Divjak and Tomić (2011), Türker and Aslan (2021) were effective in the formation of this matrix. In the thematic analysis matrix created as a result of the research, the type of research, purpose, results, methodology, design, participant type, number of participants, game type, number of games, mathematics learning areas to which the games relate, data collection instruments, types of data analysis, methods used to determine validity and reliability, and information on the national and international scale of the studies correspond to the 15 main

themes created by conducting the content analysis.Observing the main themes in the thematic analysis matrix, the two researchers recorded the results of the content and descriptive analysis of the 80 studies using the Microsoft Excel program. In this process, the researchers' collective opinions on the subthemes were evaluated, which were created a total of 6 times, meeting every 15 days.In addition, this process was checked by a colleague at frequent intervals. As a result of the examinations, 111 sub-themes were found with the common opinion of both researchers and a colleague. The main themes used and the sub-themes that emerged as results of the analysis are presented in Table 2.

Table 2. Information on main themes and sub-themes

Themes	Sub-Themes
Year of Publication	2017-2018-2019-2020-2021
Type of Study	Conference Paper - Article - Master's Thesis - Doctoral Thesis
National and International Scale Information of Studies	Journal Index - Thesis Database - Conference Information
Purpose of Study	Determining Effect - Game Design - Obtaining Opinions - Compiling Previous Studies - Presenting a Theoretical Infrastructure for Relationship between Mathematics and Games
Research Methodology	Qualitative Methodology - Quantitative Methodology - Mixed Methodology - Theoretical Methodology
Research Design	Experimental Designs - Correlation - Survey - Meta-Analysis - Phenomenological Study - Case Study - Meta-Synthesis - Action Research - Convergent Mixed Design - Exploratory Sequential Design - Explanatory Sequential Design - Parallel Conversion Design - Mixed Embedded Design – Design Not Specified
Participant Type	Preschool Students - Primary School Students - Secondary School Students - High School Students - Primary & Secondary School Students - Primary School Students & Primary School Teachers - Secondary School Students & Mathematics Teachers - Preservice Teachers - Parents - Documents - Teachers
Number of Participants	1-20; 21-41; 42-62; 63-83; 84-104; 105-125; 126 or more
Type of Game	Computer Game - Educational Game - Cultural Game - Computer Game & Educational Game
Number of Games	1-5 Games; 6-10 Games; 11-15 Games; 16 or more Games; Not Specified
Mathematics Learning Areas that Games are Related to	Numbers and Operations - Algebra - Geometry - Measurement - Data - Probability - Number Sense - Mathematical Skills - Statistics
Data Collection Tools	Questionnaire - Achievement Test - Interview - Observation - Audio-Video Recordings - Photographs - Skill/Aptitude Tests - Student Activities - Diary Records - Scales - Other - Document - Not Specified
Data Analysis Types	T-test - Mann-Whitney U Test - Wilcoxon Signed-Rank Test - Regression Analysis - Chi-Square - Pearson Product-Moment Correlation - Anova Test - Ancova Test - Descriptive Statistics - Kruskal-Wallis Test - Hierarchical Linear Modelling - Content Analysis - Descriptive Analysis - Z Statistic
Validation Methods	Item Discrimination and Reliability Index - Table of Specification - Expert Opinion - Examples of Previous Studies - Detailed Description of Process - Factor Analysis - Participant Observation - Data Triangulation - Literature Support - Not Specified
Reliability Determination Methods	Test-Retest Method - Intercoder Agreement - KR-20 - KR-21 - Cronbach Alpha - Interrater Correlation - Direct Quotation - Detailed Explanation of Data Analysis and Collection Processes - Data Triangulation - Expert Observation - Not Specified
Research Results	Positive Effect Observed - No Difference Observed - Different Levels of Effect between Variables Observed - Negative Effect Observed – Other (views, attitude, etc.)

In order to provide ease of understanding for the reader, the data collected under the themes and sub-themes in the matrix shown in Table 2 are presented by determining their percentages on the graphs created through the program with which the data were processed. In addition, the frequencies of the studies corresponding to the percentages and the code information for the studies in question are given in the comments below the graphs.

Credibility

The main themes used for the study's credibility (reliability and validity) were determined by considering the literature. Sandelowski, Barroso and Voils (2007) discussed the necessity of researchers to carry out the analysis process by adhering to the method to ensure meta-synthesis validity. This study also ensured that both researchers remained faithful to the thematic analysis matrix during the content analysis process. When analysing qualitative research data, it is recommended that the analyses are checked comparatively (Denzin &

Lincoln, 2011). For this purpose, the researchers came together at certain intervals and shared their ideas about the sub-themes they had created so far. After the sub-themes were determined, the researchers randomly selected one study from each determined main theme and analysed it individually. Following the individual examinations, the data were compared, and it was seen that the researchers agreed with the great majority of the analyses. Moreover, for the validity of the sub-themes that were created, the method of reanalysis of data applied by Kaleli-Yılmaz (2015) was used. For this purpose, one researcher re-coded the data about a month after completion of the data analysis. The consistency between the first and last coding made by the researcher was calculated as 93%. Creswell (2017) also considered it necessary to ensure transparency in qualitative research. For this reason, to ensure their transparency, the documents used in the analysis stage were recorded to preserve them.

Results

The data analyses included under this heading were evaluated in the context of the research questions and are presented accordingly.

Distribution of the Studies by Type and Year

The results of the distribution by year of the 80 studies examined in the study are shown in Graph 1.
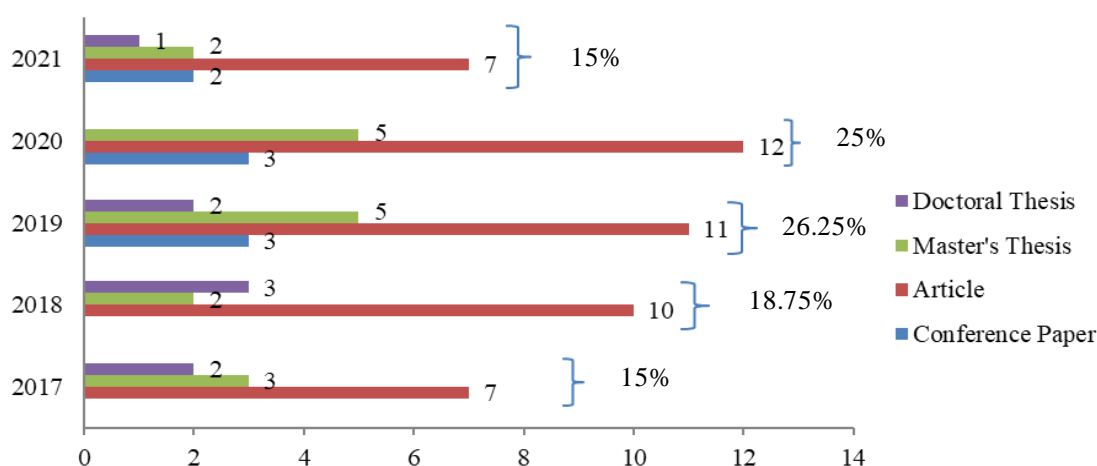

Graph 1. Distribution of the 80 studies

According to Graph 1, it is seen that a total of 12 studies, including 7 articles, 3 master's theses and 2 doctoral theses, were conducted in 2017 (DTF1, DTF2, AT1, AT2, AT6, AF3, AF4, AF5, AF7, MT1, MT2, and MT3). These studies comprise 15% of all studies. A total of 15 studies, comprising 10 articles, 2 master's theses and 3 doctoral theses, were conducted in 2018 (DTT3, DTF4, DTF5, AT9, AT10, AT8, AF11, AF13, AF14, AF15, AF17, AF12, AF16, MT4, and MT5). These studies correspond to a percentage of 18.75%. It can be understood that a total of 21 studies, namely 3 conference papers, 11 articles, 5 master's theses and 2 doctoral theses, were carried out in 2019 (PT1, PT2, PT3, DTT6, DTF7, AT18, AT19, AT20, AT25, AT26, AF21, AF22, AF23, AF24, AF27, AF28, MT10, MT6, MT7, MT8, and MT9). These studies comprise a 26.25% segment. A total of 20 studies, including 3 conference papers, 12 articles and 5 master's theses, were conducted in 2020 (PT4, PF5, PF6, AT29, AT30, AT31, AT32, AT35, AF33, AF34, AF36, AF37, AF38, AF39, AF40, MT11, MT12, MT13, MT14, and MT15). It can be seen that these studies correspond to a percentage of 25% of all studies. It can be understood that a total of 12 studies, namely 2 conference papers, 7 articles, 2 master's theses and 1 doctoral thesis, were carried out in 2021 (PF7, PF8, DTF8, AT43, AT44, AT45, AF46, AF41, AF42, AF47, MT16, and MT17). These studies make up 15% of all studies. According to Graph 1, it can be seen that most of the studies were academic articles. In terms of years, it can be said that most studies belong to the year 2019.

### National and International Distribution of the Conducted Studies

Among the 80 studies examined within the scope of the research, 42 were carried out by local authors and 38 by foreign authors. Among these studies, 47 articles were conducted, 18 by Turkish and 29 by foreign authors. The journal index distributions showing the position of the articles on a national and international scale are shown in Graph 2.
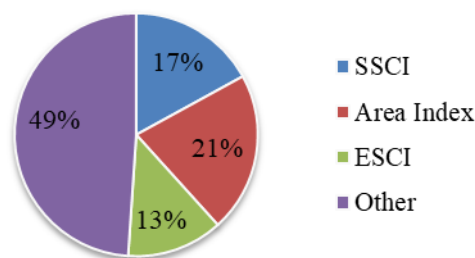
Graph 2. Journal indexes of reviewed articles

According to Graph 2, the articles scanned in other indexes constitute a 48% segment. In this context, it is seen that there are 23 articles (AT9, AT10, AT18, AT35, AT43, AT8, AF14, AF16, AF17, AT1, AF21, AT25, AT26, AF24, AF28, AT29, AF41, AF27, AF39, AT44, AT45, AF46, and AF47). Studies in journals within the scope of the SSCI constitute 17% of all studies. In this context, there are 8 articles (AF11, AF3, AF7, AF13, AF23, AF36, AF37, and AF38). Studies scanned in the ESCI index correspond to a value of 12%. Within this scope, there are 6 articles (AF4, AF5, AF12, AF15, AF22, and AF40). Articles included in the area index correspond to a percentage of 23%. The number of articles evaluated in this context is 10 (AT6, AT19, AT20, AF34, AT30, AT31, AT32, AF33, AT2, and AF42).

Of the 25 postgraduate theses examined within the scope of the research, 17 are master's theses and 8 are doctoral theses. All of the master's theses belong to Turkish researchers. Two of the doctoral theses were written by Turkish researchers, while 6 of them were written by foreign researchers. The thesis database distributions showing the place of the theses on a national and international scale are as shown in Graph 3.
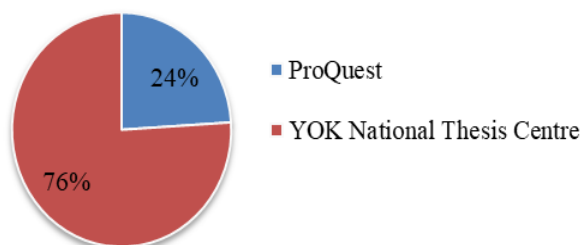
Graph 3. Databases of reviewed theses

According to Graph 3, 76% of the thesis studies were accessed from the YOK National Thesis Centre database. It can be seen that there are 19 studies within this scope (MT1, MT2, MT3, MT4, MT5, MT6, MT7, MT8, MT9, MT10, MT11, MT12, MT13, MT14, MT15, MT16, MT17, DTT3, and DTT6). The theses accessed from the ProQuest database comprise 24% of all thesis studies. In this context, there are 6 thesis studies (DTF1, DTF2, DTF4, DTF5, DTF7, and DTF8).

The conference information showing the national and international scale of the papers examined within the scope of the research is as shown in Graph 4.
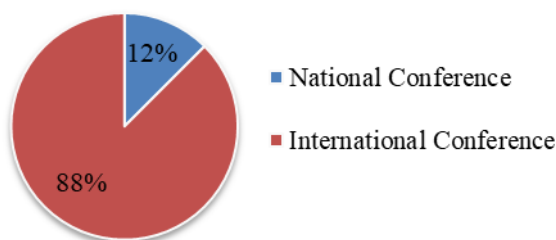

Graph 4. Conference information of reviewed papers

As seen in Graph 4, the papers included in national conferences correspond to a value of 12%. Studies evaluated in the international context constitute 88% of all studies. One paper was presented at a national conference (PT2), while 7 papers were presented at international conferences (PT1, PT3, PT4, PF5, PF6, PF7, and PF8). Of the 8 conference papers, 4 belong to Turkish researchers (PT1, PT2, PT3, PT4), while 4 belong to foreign researchers (PF5, PF6, PF7, and PF8). The 7 papers presented at international conferences are full texts (PT1, PF7, PT4, PT3, PF5, PF8, and PF6). The one paper presented at the national conference is a summary text (PT2). The papers examined within the scope of the research were presented at social sciences conferences, engineering and education conferences, preschool education conferences, education conferences, and at conferences on learning analytics and knowledge with materials science and engineering.

Distribution of the Studies According to their Purposes

The results regarding the purposes of the 80 studies examined in the study are shown in Graph 5.
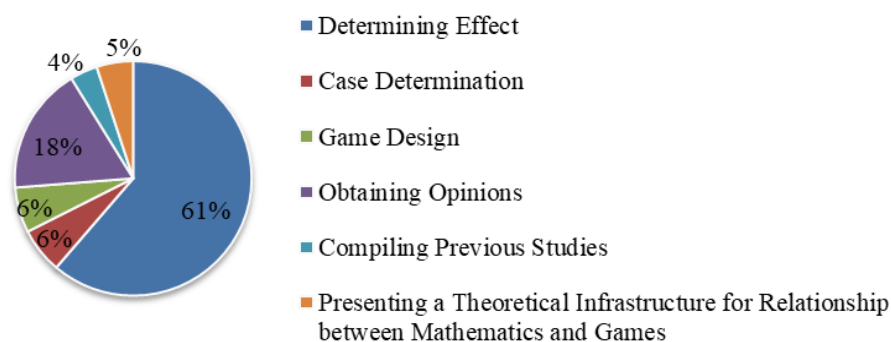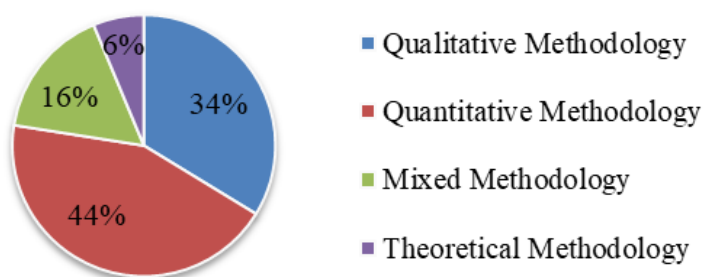

Graph 5. Purposes of reviewed studies

According to Graph 5, it can be seen that 61% of the studies using games in mathematics education were conducted to determine the effect. These studies are 49 in number (PT1, DTT3, DTT6, DTF7, DTF1, DTF2, DTF4, DTF5, DTF8, AT9, AT10, AT18, AT35, AT43, AT8, AF11, AF12, AF13, AF15, AF16, AF17, AF21, AF22, AF23, AF24, AF28, AF34, AF36, AF37, AF38, AF40, AF41, AF4, AF7, MT1, MT10, MT11, MT12, MT13, MT14, MT16, MT17, MT2, MT3, MT5, MT6, MT7, MT8, and MT9). Studies conducted to determine cases accounted for 6% of the total. It was found that 5 studies were performed for case detection (MT4, PF6, MT15, AF46, and AF42). It can be seen that the studies conducted for the purpose of game design have a share of 6%. Five studies aimed to design games that can be used in mathematics education (PF7, PF8, AT2, AT44, and AF47). Fourteen studies were conducted to use games in mathematics education or to obtain opinions about the games used (PT2, PT3, PT4, AT1, AT19, AT20, AT25, AT26, AT29, AT30, AT31, AT32, AF27, and AF33). These studies comprise 18% of all studies. Three studies were conducted to compile previous studies (AT6, AF39, and AT45), making up 4% of all studies. Four studies were conducted to reveal the relationship between mathematics and games (PF5, AF3, AF5, and AF14). These studies constitute 5% of all studies.

Distribution of the Studies According to their Methodologies and Designs

The results related to the methodology of the 80 studies that were examined in the study are shown in Graph 6


Graph 6. Methodologies of reviewed studies

According to Graph 6, studies conducted with a quantitative method make up 44% of all studies. The number of these studies corresponds to 35 of the 80 studies (PT1, PF5, PF6, DTF1, DTF2, DTF4, DTF5, DTF8, AT9,

AT10, AT35, AT43, AT6, AT8, AF11, AF13, AF15, AF17, AF21, AF22, AF23, AF24, AF37, AF38, AF40, AF41, AF42, MT10, MT12, MT13, MT14, MT16, MT17, MT3, and MT8). Studies using a qualitative method constitute 34% of all studies. Accordingly, 27 studies were conducted with a qualitative method (PT2, PT3, PT4, AT1, AT19, AT20, AT25, AT26, AT2, AT29, AT30, AT31, AT32, AT44, AT45, AF12, AF16, AF27, AF28, AF33, AF39, AF46, AF4, MT11, MT15, MT4, and MT9). Studies using mixed methods comprise 16% of all studies. Accordingly, it is seen that 13 studies are mixed method studies (DTT3, DTT6, DTF7, AT18, AF34, AF36, AF3, AF7, MT1, MT2, MT5, MT6, and MT7). Five studies were evaluated in the theoretical context (justification based on the literature) (PF7, PF8, AF14, AF47, and AF5). These studies constitute 6% of all studies.

The results with regard to the design of the 80 studies examined as part of the study are shown in Graph 7.
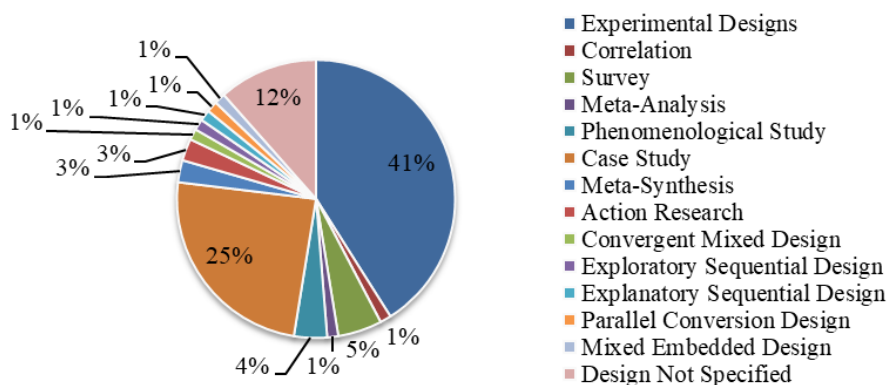

Graph 7. Designs of reviewed studies

According to Graph 7, studies carried out with an experimental design constitute 41% of all studies. Accordingly, it can be understood that experimental designs were preferred in 32 studies (PT1, DTT3, DTF1, DTF2, DTF4, DTF8, AT9, AT10, AT35, AT43, AT8, AF11, AF13, AF15, AF21, AF22, AF23, AF24, AF37, AF38, AF40, AF41, MT10, MT11, MT12, MT13, MT14, MT16, MT17, MT3, MT7, and MT8). Case studies comprise 25% of all studies. Accordingly, 19 studies were conducted as case studies (PT2, PT4, AT1, AT19, AT25, AT26, AT2, AT30, AT31, AT32, AT44, AF14, AF27, AF28, AF33, AF46, AF4, MT15, and MT4). It can be understood that 9 studies do not have design information, with a share of 12% (PT3, PF7, PF8, AT18, AF3, AF47, AF5, AF7, and MT1). Studies using a survey design account for 5% of all studies. Accordingly, 4 studies were carried out with a survey design (PF5, PF6, AF17, and AF42). Phenomenology studies weight 4%. It can be understood that 3 studies are phenomenological studies (AT20, AT29, and AF12). There is 1 study conducted as a meta-analysis study (AT6), which corresponds to 1% of all studies. Two studies were conducted as meta-synthesis studies (AT45 and AF39). These studies constitute 3% of all studies. There is 1 study conducted with a correlational survey design (DTF5), comprising 1% of all studies. One study was conducted using a mixed embedded design (MT21), constituting 1% of all studies. It is seen that there are also single studies using an explanatory sequential design (MT6), a parallel conversion design (AF34), a convergent mixed design (DTF7), and an exploratory sequential design (DTT6). These studies each have a weight of 1% among the studies examined. The two studies conducted with an action research design comprise 3% of all studies (AF16 and MT9).

**Distribution of the Studies According to the Type and Number of Participants**

The results related to the participant type of 75 studies (3 studies that present a theoretical background, and 2 game design studies were excluded) examined within the scope of the research are shown in Graph 8.
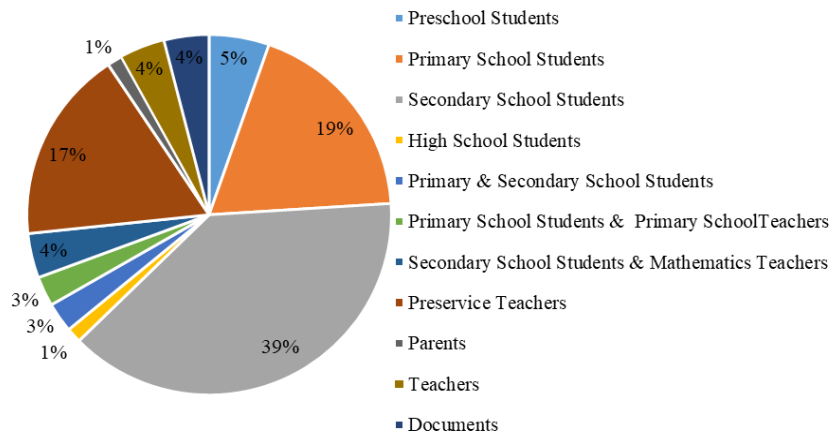
Graph 8. Participant type in reviewed studies

According to Graph 8, studies determining secondary school students as participants constitute 39% of all studies. Within this scope, 30 studies were conducted (PF5, PF7, DTT6, DTF7, DTF1, DTF4, DTF5, AT9, AT10, AT32, AT35, AT43, AF13, AF16, AF17, AF21, AF28, AF37, AF7, MT11, MT12, MT14, MT15, MT17, MT2, MT3, MT4, MT6, and MT9). Studies in which primary school students participated comprised 19% of all studies. Accordingly, it is seen that primary school students participated in 14 studies (PT1, PF6, DTT3, DTF8, AT18, AT8, AF22, AF34, AF38, AF4, MT1, MT10, MT16, and MT7). Preservice teachers participated in 13 studies (PT3, PT4, DTF2, AT1, AT19, AT25, AT26, AT2, AT29, AT30, AT31, AT44, AF41, and AF42). These studies make up 17% of all studies. Preschool students participated in 4 studies (AF11, AF24, AF23, and MT8). These studies constitute 5% of all studies. There are 3 studies in which teachers took part as participants (AT20, FY28, and FY43), and these studies account for 4% of all studies. There are 3 studies in which secondary school students and mathematics teachers participated together (AF12, AF46, and AF3). These studies constitute 4% of all studies. There are 3 studies including documents (AT45, AT6, and AF39), which correspond to 4% of all studies. Two studies include primary and secondary school students (AF15 and AF36). These studies account for 3% of all studies. Two studies were conducted in which primary school students and primary school teachers took part (AF33 and MT5). These studies make up 3% of all studies. One study was conducted in which parents took part (PT2), while one study was carried out in which high school students (MT13) participated. These studies each constitute 1% of all studies.

The results of 75 studies (3 studies that present a theoretical background, 1 meta-analysis and 1 meta-synthesis studies were excluded) examined within the scope of the research in terms of the number of participants calculated as individuals, as seen in Graph 9.
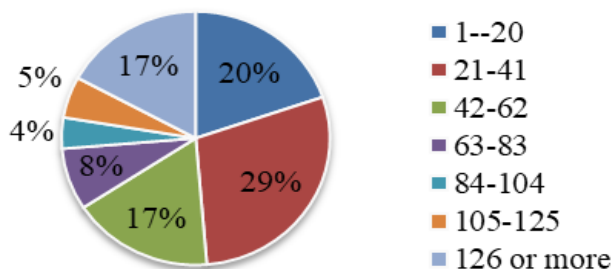

Graph 9. Number of participants in reviewed studies

According to Graph 9, 22 studies included between 21 and 41 participants with a percentage of 29% (PT2, PT3, DTT3, DTF7, AT9, AT10, AT25, AT26, AT32, AT44, AT45, AT6, AT8, AF28, AF39, AF46, MT1, MT11, MT12, MT13, MT14, and MT8). 15 studies included some participants between 1 and 20 (PT4, PF7, AT1, AT19, AT20, AT30, AT31, AF12, AF27, AF4, AF7, MT15, MT17, MT4, and MT9). These studies comprise 20% of all studies. Studies including some participants between 42 and 62 correspond to a percentage of 17%. There are 13 studies within this scope (PT1, MT2, DTF4, DTF5, AT35, AT43, AF11, AF16, AF24, MT10, AF33, AF34, and MT6). It can be seen that there are 14 studies with 126 participants or more, corresponding to a value of 17% (PF5, PF6, DTF8, AT2, AF15, AF22, AF23, AF36, AF37, AF3, AF41, AF42, and MT3). It is

seen that 6 studies included between 63 and 83 participants, and this corresponds to a share of 8% (DTF1, DTF2, DTT6, AF21, AT29, and MT16). Studies involving 105 and 125 participants account for 5% of all studies, corresponding to 4 studies included in this scope (AT18, AF38, AF40, and MT7). 3 studies included some participants between 84 and 104 (AF13, AF17, and MT5). These studies correspond to 4% of all studies.

Distribution of Research by Game Type, Number, and Mathematical Learning Domains to Which the Games Pertain

After excluding 1 meta-analysis and 1 meta-synthesis study, the results of the distribution of the remaining 78 studies examined in the search by game type are shown in Graph 10.
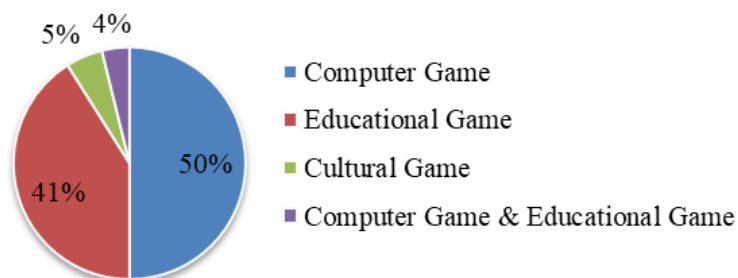
Graph 10. Game types of reviewed studies

According to Graph 10, the percentage of studies using computer games constitutes a share of 50% of all studies. Within this scope, it is seen that 39 studies use digital computer games (PT3, PT4, PF5, PF6, PF7 , PF8, AF3, AF4, AF5, AF7, AT10, AF12, AF13, AF15, AF21, AF22, AT25, AF28, AT30, AT31, AF33, AF34, AF36, AF37, AF38, AF39, AF40, AF41, AF42, AF46, MT2, MT9, MT13, DTF1, DTF2, DTF4, DTF5, DTF7, and DTF8). Studies using educational games make up 41% of all studies. In this context, it can be understood that educational games are used in 32 studies (PT1, DTT3, DTT6, AT1, AT9, AT18, AT20, AT2, AT32, AT35, AT43, AT44, AT8, AF11, AF16, AF17, AF23, AF24, AF27, MT1, MT10, MT11, MT12, MT14, MT16, MT17, MT3, MT4, MT5, MT6, MT7, and MT8). It is seen that 4 studies, in which cultural games are used, account for a share of 5% (AF14, AT26, AF47, and MT15). It can be seen that the studies using both computer and educational games correspond to a value of 4%. There are 3 studies that fall within this range (PT2, AT19, and AT29).

The distribution according to the number of games used in the 78 studies examined is as shown in Graph 11.
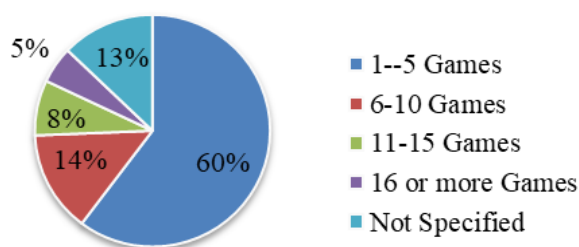

Graph 11. Number of games used in reviewed studies

As shown in Graph 11, the proportion of studies using 1-5 matches is 60% in this study. In this context, it is seen that 47 studies were conducted (PT1, PT4, PF5, PF6, AF3, AF4, AF5, AF7, AT10, AF11, AF13, AF14, AF15, AF16, AF17, AF21, AF22, AT26, AF28, AT30, AT31 , AT32, AF33, AF34, AF36, AF37, AF40, AF41, AT43, AF46, AF47, MT4, MT5, MT6, MT8, MT9, MT13, MT14, PF7, PF8, DTF8, MT17, DTF1, DTF2, DTF4, DTF5, and DTF7). Studies using 6-10 games make up a percentage of 14% of all studies. It is seen that there are 11 studies included in this range (AT18, AF23, AT25, MT1, MT3, MT7, MT10, MT11, MT15, DTT3, and DTT6). Studies in which the number of games used is not specified correspond to a value of 13%. It can be seen that these studies are 10 in number (PT2, PT3, AT1, AF12, AT19, AT20, AF24, AF27, AT29, and AF42). Studies using some games among 11-15 constitute a value of 8%. In this context, it is seen that there are 6 studies (AT8, AT35, AF38, MT2, MT12, and MT16). Studies in which 16 or more games are used constitute

5% of all studies. In this context, it was determined that 4 studies were carried out (AT2, AT9, AF39, and AT44).

It can be seen that the games used in 80 studies examined within the scope of the research address more than one learning area. For this reason, attention was paid to how often the learning domains were the subject of investigation when the chart was created.Accordingly, the distribution of the mathematics learning areas to which the games used in the research are related can be seen in Graph 12.
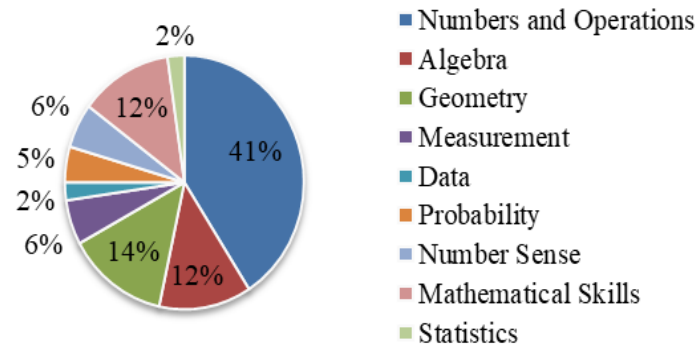

Graph 12. Mathematics learning areas that reviewed studies are related to

According to Graph 12, the "numbers and operations" learning area constitutes 41% of all learning areas. It was determined that 36 studies were conducted in this context (PT1, PF6, PF7, PF8, AF4, AF5, AF7, AT8, AT10, AF11, AF15, AF17, AT18, AF22, AF24, AF27, AT32, AF34, AF36, AF37, AT44, MT1, MT2, MT4, MT6, MT7, MT9, MT10, MT11, MT14, MT15, MT16, DTF2, DTF4, DTT6, and DTF8). Studies dealing with the "geometry" learning area correspond to a value of 14%. In this context, there are 12 studies (AT1, AF4, AF9, AT31, AF34, AT44, MT3, MT5, DTF2, DTT3, DTF4, and DTF8). Studies in the learning area of "algebra" constitute 12% of all studies. In this context, 11 studies were carried out (PF7, AF21, AF28, AT44, AF46, AF47, MT17, DTF2, DTF4, DTF5, DTF7, and DTF8). The "measurement" learning area constitutes 6% of all learning areas. Within this scope, there are 5 studies (PF6, AT8, DTF1, DTF2, and DTF8). Studies prepared for "mathematical skills" constitute 12% of all studies. It is seen that 11 studies were included in this scope (AF12, AF13, AF14, AF16, AT30, AF33, AF38, AF40, AF41, AF42, and AT43). The games used in 5 studies aim at creating "number sense", comprising 6% of all studies (AF11, AF23, AF24, AF27, and MT8). It was determined that the games used in 4 studies were prepared for the "probability" learning area (AF5, AT44, MT12, and DTF4). Studies conducted within this scope account for 5% of all studies. Studies dealing with the "data" learning area correspond to a value of 2%. It was observed that there are 2 studies in this context (AT8 and AT44). Studies carried out in the "statistics" learning area account for 2% of all studies. In this context, it is seen that there are 2 studies (AF5 and DTF4).

Distribution of Data Collection Tools, Data Analysis Types, and Validity and Reliability Methods Used in the Conducted Studies

Since 4 of the 80 studies examined in the research were conducted at the theoretical level, they did not require the use of a data collection tool. In the remaining 76 studies, it is understood that more than one data collection tool was used. Accordingly, the obtained results are as seen in Graph 13.
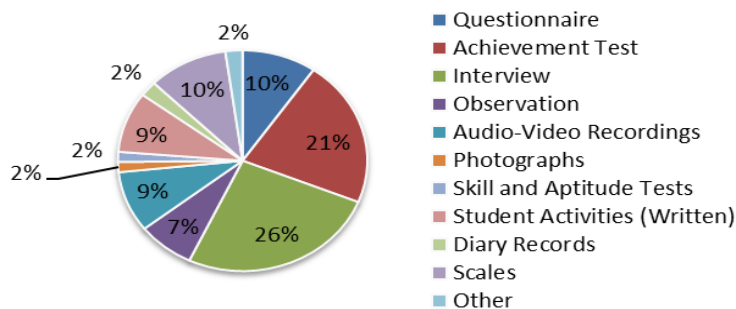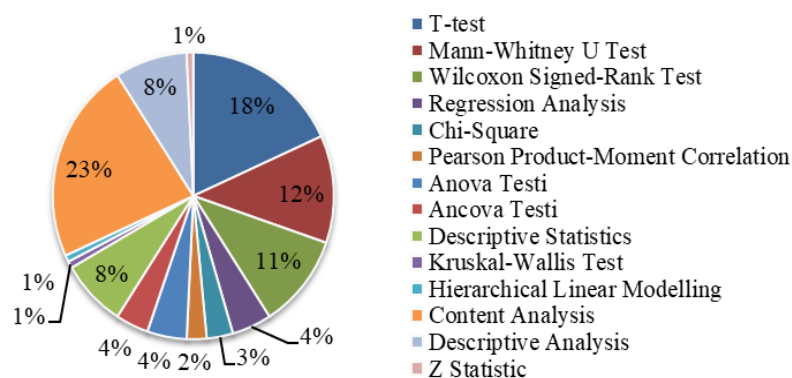

Graph 13. Data collection tools used in reviewed studies
*The information in Graph 13 was created by considering all the data collections used in the studies.

According to Graph 13, studies that collected data through interview constitute 26% of all studies. There are 35 studies included in this scope (PT2, PT3, PT4, AT1, AT2, AF3, AF4, AF12, AF13, AF16, AT18, AT19, AT20, AT25, AT26, AF27, AF28, AT32, AF33, AF34, AF36, AF41), AF46, MT1, MT2, MT4, MT5, MT6, MT7, MT9, MT12, MT14, MT15, MT17, and DTF7). Studies in which achievement tests were used as data collection tools correspond to a value of 21%. In this context, there are 29 studies (PT1, AT8, AT9, AT10, AF11, AF13, AT18, AF21, AF22, AF28, AF34, AT35, AF38, AF40, AF41, AT43, MT1, MT2, MT6, MT7, MT10, MT11, MT12, MT13, MT14, MT16, DTT6, DTF7, and DTF5). Data were collected through scales in 14 studies, with a value of 10% (AT18, AF23, AF37, AT43, MT5, MT6, MT7, MT8, MT10, MT11, MT13, MT17, DTF2, and DTT6). Questionnaires were utilised in 13 studies (PF7, PF8, AF3, AF13, AF17, AF22, AF28, AF36, AF40, AF42, DTF1, DTF4, and DTF8). These studies correspond to 10% of all studies. Studies utilising audio-video recordings as data collection tools comprise 9% of all studies. In this context, 12 studies were identified (AF4, AF7, AF16, AT18, AF28, AT30, AT31, AF34, MT1, MT4, MT7, and MT15). The 10 studies utilising observations correspond to 7% of all studies (AT2, AF4, AT18, AF27, AF33, AF46, MT1, MT2, MT7, and MT15). Various criteria and forms for document analysis were used as data collection tools in the 3 studies included under the "other" heading (MT5, AT29, and AF33). These studies make up 2% of all studies. Studies in which skill and aptitude tests were used as data collection tools correspond to a value of 2%. Within this scope, 2 studies were conducted (MT3 and DTT3). Diaries were used as data collection tools in 2% of the studies. There are 3 studies in this context (AF15, AF28, and MT12). Studies in which photographs were used as data collection tools account for 2% of all studies. In this context, there are 2 studies (AF16 and AF28). 12 studies use data collection tools based on student activities (grades, game scores, question solutions, etc.) (PF5, PF6, AF7, AF15, AF24, AT25, AF28, AF37, AF41, MT4, MT15, and DTF5). These studies correspond to 9% of all studies. One study in which a document prepared as a guide was used as the data collection tool corresponds to 1% of all studies (AT44). In 2 studies, no information is given about how the data were collected, constituting 1% of all studies (AT6 and AT45).

It was observed that more than one analysis test was used to analyse the data of the 80 studies examined within the scope of the research. For this reason, examination was made on how many times the analyses were used in the studies. Accordingly, the results obtained are as seen in Graph 14.
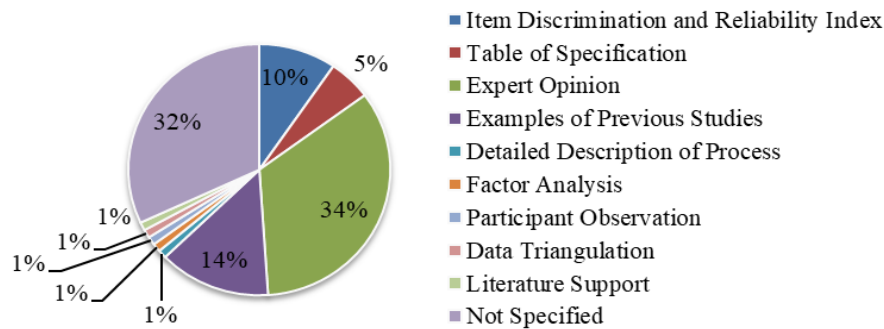

Graph 14. Data analyses used in reviewed studies
*The information in Graph 14 was created by considering all the analysis methods used in the studies.

According to Graph 14, studies conducted with content analysis constitute 23% of all studies. It can be seen that there are 30 studies in this context (PT2, PT3, PT4, AT1, AT2, AF4, AF7, AF12, AF16, AT19, AT20, AT25, AT26, AF27, AF28, AT29, AT32, AF33, AF34, AF36, AF39, AT45, MT1, MT2, MT4, MT15, MT17, DTT3, DTT6, and DTF7). Studies in which t-test analysis was performed constitute 18% of all studies. Within this scope, there are 24 studies (PT1, AT8, AF11, AF13, AT18, AF34, AF36, AF37, AF38, AF40, AF41, AT43, MT1, MT2, MT3, MT7, MT10, MT12, MT14, MT16, MT17, DTF1, DTF4, DTF5, and DTT6). Studies using Wilcoxon signed-rank test analysis correspond to a 11% value. In this context, it is observed that there are 14 studies (AT9, AT10, AF15, AT35, AT43, MT5, MT6, MT8, MT11, MT13, MT17, DTF2, DTT3, and DTT6). Studies using descriptive statistics comprise 8% of all studies. It is seen that 10 studies were carried out in this context (AT18, AF21, AF24, AT32, AF41, AF42, MT13, MT14, DTF5, and DTF8). Studies using descriptive analysis also correspond to 8% of all studies. There are 11 studies included in this scope (PF5, AF28, AT30, AT31, AT44, AF46, MT4, MT5, MT6, MT9, and MT14). Studies in which Anova test analysis was performed account for 4% of all studies. In this context, it is seen that there are 6 studies (AF11, AF22, AF23, AF36, AF37, MT1, and DTF8). Studies in which Mann-Whitney U test analysis was performed comprise 12% of all studies, and these are 16 in number (AT9, AT10, AF15, AT35, AT43, MT2, MT5, MT6, MT8, MT10, MT11,

MT12, MT13, MT16, DTF2, and DTT3). The 6 studies in which regression analysis was performed make up 4% of all studies (PF5, PF6, AF4, AF34, AF40, and DTF5). Studies in which the Ancova test was used correspond to a value of 4%. Within this scope, it can be seen that there are 5 studies (PT1, AF21, AF24, DTT6, and DTF7). Studies using Pearson product-moment correlation analysis correspond to a value of 2%. There are 3 studies evaluated in this context (AF22, AF24, and AF41). Studies using chi-square analysis correspond to 3% of all studies. In this context, 4 studies were conducted (AF5, AF17, AF34, and AF42). There is one study using hierarchical linear modelling (DTF1), one in which the Kruskal-Wallis test was performed (AF15), and one in which Z statistical analysis was performed (DTF5). These studies each constitute 1% of all studies.

Four of the 80 studies examined within the scope of the research were excluded from the scope of the analysis because they were of the type (theoretical) for which a validity study could not be carried out. Accordingly, the results regarding the validation methods used in the 76 studies examined are as shown in Graph 15.
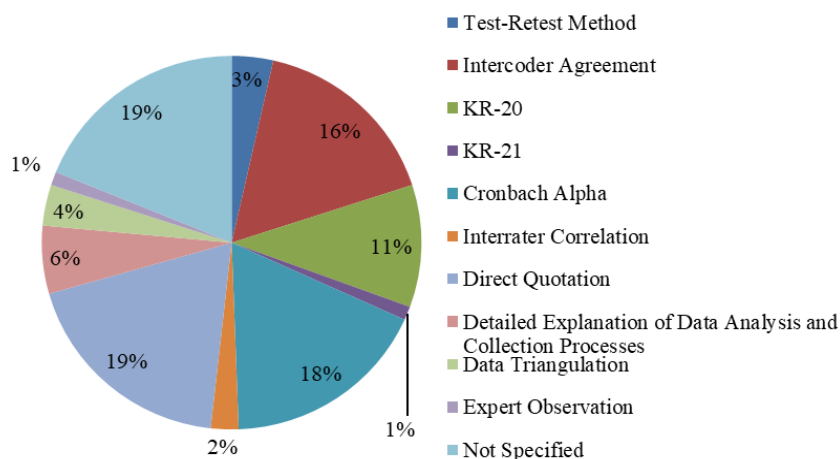

Graph 15. Validation methods of reviewed studies
*The information in Graph 15 was created by considering all the validation methods used in the studies.

According to Graph 15, studies in which expert opinion was sought as a validation method constitute 34% of all studies. In this context, there are 32 studies (PT1, PT2, PT3, PT4, PF7, AT1, AT8, AT9, AT10, AT18, AT19, AT20, AF21, AT25, AT26, AT29, AT30, AT31, AT32, AT35, AF39, AT45, MT5, MT6, MT7, MT9, MT10, MT11, MT14, MT15, MT16, and DTF8). Studies for which a validation method is not specified correspond to a value of 32%. There are 30 studies for which no validation method is specified (PF5, PF6, AT2, AF3, AF4, AF7, AF11, AF12, AF13, AF15, AF17, AF22, AF23, AF24, AF27, AF28, AF33, AF37, AF38, AF40, AF42, AT43, AT44, AF46, AF47, MT2, MT3, DTF1, DTF2, and DTF4). Studies that show examples of previous studies in the literature as a validation method constitute 14% of all studies. 13 studies were conducted (PT2, AF16, AT18, AT20, AF34, AF36, AF41, MT4, MT8, MT12, MT13, DTF5, and DTF8). Studies in which item discrimination and difficulty index analysis was used correspond to a value of 10%. In this context, there are 9 studies (AT8, AT9, MT2, MT6, MT10, MT14, MT16, DTT3, and DTT6). Studies in which a table of specifications was used as the validation method comprise 5% of all studies. It is seen that there are 5 studies included in this scope (PT1, AT8, AT9, MT6, and DTT3). A detailed process description ensured validity in one study in which a qualitative method was used. This study constitutes a value of 1% (DTT6). One study used factor analysis as the validation method corresponds to 1% of all studies (MT11). One study was conducted in which validity was ensured by participant observation (MT17), and this study represents a value of 1% of all studies. There is only one study in which validity was ensured by data triangulation, and this study also constitutes 1% of all studies (DTF7). There is 1 study where validity was ensured based on the literature (MT1), which corresponds to a value of 1% of all studies.

Four of the 80 studies examined in the study were not included in the analysis because they were of the type (theoretical) for which a reliability study could not be performed. Accordingly, the results regarding the methods used to ensure reliability in the 76 studies examined are as seen in Graph 16.

Graph 16. Methods of ensuring reliability in reviewed studies
*The information in Graph 16 was created by considering all the reliability methods used in the studies.

According to Graph 16, the studies examining the Cronbach alpha coefficient as the method of determining reliability constitute 18% of all studies. In this context, it was seen that 15 studies were carried out (AT10, AT35, AF13, AF15, AF23, AF24, AF38, PT1, MT5, MT6, MT11, MT16, MT17, DTF5, and DTT6). The percentage of studies that do not specify a reliability determination method is 19%. In this context, it can be seen that 16 studies do not provide information about the reliability determination method (PF5, PT3, AF3, AF4, AF16, AF17, AF21, AF28, AF42, AT43, AF46, AF47, MT3, MT7, DTF2, and DTF7). Studies in which intercoder agreement was used as the reliability method correspond to a value of 16%. There are 14 studies within this scope (PT4, PF7, AT1, AT2, AF7, AF22, AT25, AT29, AF34, AT44, DTT6, MT9, MT12, and MT14). Studies in which direct quotations were preferred as the method of reliability constitute 19% of all studies. In this context, there are 16 studies (PT2, AT1, AT2, AF7, AF12, AT18, AT19, AT20, AT26, AF27, AT31, AT32, MT1, MT4, MT9, and DTT3). Studies in which KR-20 was used as the reliability method cover 11% of all studies. KR-20 calculations were made in 9 studies (AT8, AT9, MT2, MT8, MT10, MT13, MT14, DTT3, and DTT6). The percentage of studies in which KR-21 was used as the reliability method corresponds to a value of 1%. In this context, there is 1 study (MT13). A detailed explanation method for the data analysis and collection process was used in 5 studies (AF27, AT30, AT31, AF41, and MT15) and these studies correspond to a value of 6%. Data triangulation was used in 3 studies (AT20, AF33, and MT4), comprising 4% of all studies. Studies in which reliability was calculated using the test-retest method correspond to a value of 4%, and in this context, there are 3 studies (AF23, DTF1, and MT8). There are 2 studies in which the correlation value inter-coder consistency was calculated (AF39 and MT17), and these studies account for 2% of all studies. Studies in which an attempt was made to ensure reliability by consulting expert opinion constitute 1% of the studies, and there is 1 study evaluated in this context (AT45).

Distribution of the Conducted Studies According to their Results

The distribution of the results of the 80 studies that were examined as part of the study is shown in Graph 17.
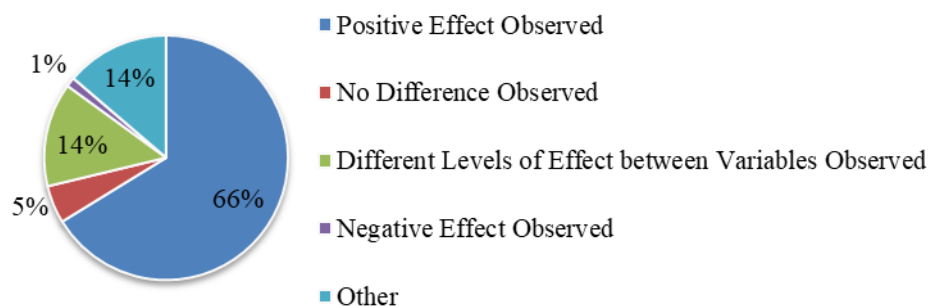
Graph 17. Results of reviewed studies

According to Graph 17, 66% of the conducted studies resulted in a positive effect. There are 53 studies included in this scope (PT1, PT2, PT4, PF7, PF8, AT1, AT6, AF7, AT8, AT9, AT10, AF11, AF13, AF15, AF16, AT18,

AT19, AT20, AF21, AF23, AF24, AT25 , AT26, AF27, AF28, AT29, AT30, AT31, AT32, AF33, AF34, AT35, AF38, AF41, AF42, AT45, AF46, DTF1, DTT3, DTF5, DTT6, MT1, MT5, MT6, MT7, MT8, MT9 , MT11, MT12, MT14, MT15, MT16, and MT17). Studies in which different levels of effect were observed between the variables correspond to a value of 14%. In this context, there are 11 studies (AF22, AF37, AT43, DTF2, DTF4, DTF7, MT2, MT3, MT4, MT10, and MT13). Studies in which different effects were not observed correspond to a value of 5%. It is seen that there are 4 studies in this scope (AF4, AF12, AF40, and DTF8). Studies evaluated within the scope of "other" studies comprise 14% of all studies. There are 11 studies in this context (PF5, PF6, AT2, AF3, AF5, AF14, AF17, AF36, AF39, AT44, and AF47). There is only one study in which a negative effect was observed (PT3), and this study corresponds to a value of 1%.

Discussion and Conclusion

This section discusses the results obtained from the study in line with the research problems. When we examine the distribution of the studies on the use of games in mathematics education according to their type, which is explained in the first sub-problem of the research, it can be said that studies of the article type gain prominence. When the distribution by years is examined, it can be seen that there is a general increase, including 2019, while the number of studies conducted in the following years shows a tendency to decrease. Especially in 2019, the maximum number of studies was reached by researchers in article, thesis and conference paper studies (Cohrssen & Niklas, 2019; Ergül & Doğan, 2019; Galarza, 2019; Liang et al., 2019; Machaba, 2019; White & McCoy, 2019; Yılmaz, 2019). If active learning brought about by a constructivist approach in mathematics teaching is desired, then games are among the most important methods to be used in this regard (Erkin-Kavasoğlu, 2010). Indeed, in recent years, studies on games in mathematics education have started to increase (Türker & Arslan, 2021). In this context, the emerging result meets the researchers' expectations. On the other hand, the reason for the decrease in the number of publications after 2019 is thought to be related to the COVID-19 pandemic process. Considering that half of the games in the studies examined are computer games, the use of technology comes to the fore. During the period COVID -19, the most important problem for teachers is the lack of technological pedagogical knowledge (Türker & Duendar, 2020). This situation can be cited as the reason for the decrease in studies on the use of games in mathematics education. In this context, the number of technology courses offered at the undergraduate level could be increased.

When the results for the second sub-problem of the research are examined, it can be seen that nearly half of the articles were scanned in indexes such as Scopus and TR indexed, while 17% of them appear in SSCI-indexed journals. When the postgraduate theses are examined, it can be seen that the great majority of studies on teaching mathematics with games are studies conducted in Turkey (Başkahya, 2021; Dönmez, 2017; Ergül, 2021; Galiç, 2020; Koç-Deniz, 2019; Sönmez, 2018). The reason for this is thought to be the 2018 curriculum announced by the Higher Education Council (YOK). In fact, together with this curriculum, the course for teaching mathematics with games was included in the programme, and after this date, studies carried out on this subject gained momentum. Participation in international conferences was mainly observed in studies conducted in the form of papers.

The results obtained for the third sub-problem of the research show that the conducted studies are mainly aimed at determining the effect of teaching mathematics with games on mathematical achievement (Kokandy, 2021; Lee & Choi, 2020; McIntosh, 2018; Stanton, 2017; Tärning & Silvervarg, 2019; Watson-Huggins, 2018). This is followed by studies in which opinions about the use of games in teaching mathematics are discussed (Bragg, 2007; Deng, Wu, Chen & Peng, 2020; Doğan & Sönmez, 2019; Machaba, 2019). In parallel with these results, when the studies are examined, it is seen that mostly experimental design studies are included in quantitative research studies (Lee & Choi, 2020; Nfon, 2018; Stanton, 2017; Yılmaz, 2019). These studies are followed by case studies included in qualitative research studies (Barreto, Vasconcelos & Orey, 2017; Marange & Adendorff, 2021; White & McCoy, 2019). In the study by Divjak and Tomic (2011) in which computer games used in mathematics education between1995-2010 were examined, it was determined that the majority of the conducted studies were carried out in accordance with the nature of quantitative research. The reason could be the study of the effects of teaching mathematics with games on different variables in the study.

The results obtained for the fifth sub-problem of the research reveal that about one-third of the sample numbers in the studies are in the range of 21-41 (Boz, 2018; Galarza, 2019; Tükle, 2020). Moreover, when the sample groups in the studies are examined, it is seen that mostly secondary school students were studied (Atasay, 2018; Divjak & Tomić, 2011; Graceota, & Slamet, 2021; Koç-Deniz, 2019), while primary school students follow this group (Ergül, 2021; Ergül & Doğan, 2019; Kokandy, 2021). In the study conducted by Türker and Arslan (2021), in which the studies on teaching mathematics with games between 2002-2017 were examined, it was determined that the sample groups consisted of primary and secondary school students. However, another

noteworthy point is that only a small number of studies was conducted with student groups at the preschool level (Liang et al., 2019; Skillen, Berner & Seitz-Stein, 2018). Yet the game is a concept that is appropriate, especially for children of preschool age, and is an important tool in the development of the child, that benefits his/her mental, psychological, biological, and sociocultural development (Gür & Kobak-Demir, 2016). In this context, it can be seen that studies on educational mathematics games belonging to the preschool period, when basic mathematical knowledge and skills are developed, should be included. Using games in mathematics may be mainly tried as a teaching method for different age groups.

When the studies conducted between 2017-2021 are examined, it is seen that 49% of the studies include computer games (Kalish, 2017; Kiili, Ojansu, Lindstendt & Ninaus, 2018; Rondina & Roble, 2019), while 42% of them include educational games (Başün & Doğan, 2020; Demirkaya, 2017; Nfon, 2018). While 61% of the studies include between 1 and 5 games (Es-Sajjade & Paas, 2020; Koneva & Shabanova, 2021), a significant percentage of the content of the games belongs to the "numbers and operations" learning area (Eyster, 2017; Galarza, 2019; Wouters & Van Der Meulen, 2020). In the research conducted by Joung and Byun (2020), in which digital mathematics games were analysed according to National Council of Teachers of Mathematics [NCTM] standards, it was determined that the majority of the games were related to the "numbers and operations" learning area. However, very few games were prepared for the "data", "statistics" and "probability" learning areas. At this point, it may be thought that more studies should be included in these learning areas that are especially important in terms of mathematical literacy, which has come to the fore recently.

It is seen that interviews were used as the data collection tool in 35 of the 80 studies examined, while achievement tests were used in 29 studies. In parallel with these results, for data analysis, most of the studies included content analysis and t-test data, which is one of the parametric tests. Furthermore, expert opinion and calculation of the Cronbach alpha coefficient were the most preferred methods used to ensure validity and reliability, respectively. In addition, it can be seen that many studies do not specify which methods were used (Koneva & Shabanova, 2021; Marange & Adendorff, 2021). Yet it is stated in studies that the quality of a study is directly proportional to good determination of validity and reliability in the study (Golafshani, 2003; Punch, 2005). It follows that methods to ensure validity and reliability in qualitative and quantitative research should be considered in future studies of mathematics education, both in this and other areas. Moreover, this situation will also facilitate the evaluation of studies.

Regarding the last sub-problem of the research, the results obtained from the studies show that in 65% of the studies, mathematics teaching with games had a positive effect. Research has shown that teaching with games increases students' academic achievement (Divjak & Tomić, 2011; Karamert, 2019; Pehlivan, 2020; Türkmen, 2017) and positively affects their attitudes toward mathematics (Tükle, 2020), and that research participants have a positive attitude toward the use of games in mathematics courses (Koç-Deniz, 2019; Russo et al., 2021; Watson-Huggins, 2018).These results are in line with previous research studies conducted on this subject (Divjak & Tomic, 2011; Turgut & Temur, 2017; Türker & Arslan, 2021). However, in studies where negative effects were observed, it was found that teachers were not aware of the use of games in mathematics teaching (Pilten, Pilten, Divrik & Divrik, 2017) and that there was a lack of harmony between technological games and pedagogical principles (Lindström, Gulz, Haake & Sjödén, 2011).In addition, results are also included on teachers' need for game materials (Kondratieva & Freiman, 2011), the low use of games in some countries (Nabie, 2008), some needs for integrating game use into the curriculum (Akintunde et al., 2020; Callaghan, Long, van Es, Reich, & Rutherford, 2017; Fouze & Amit, 2018; Graceota & Slamet., 2021; Koneva & Shabanova, 2021; Shabrina et al., 2020), the effects of designing game components and the effects of game design (Ke, 2014; Rawansyah et al., 2021; Trujillo, Chamberlin, Wiburg & Armstrong, 2016), and the inappropriateness of using games according to certain standards (NCTM) (Joung & Byun, 2020). To eliminate some negative situations, it is recommended that the Ministry of National Education act as a problem solver, e.g. through technical, material and academic support, teacher training, etc.x

Author (s) Contribution Rate

The authors contributed equally to the study.

Conflicts of Interest

The authors declare no conflict of interest.

Ethical Approval

This study not need ethical approval in terms of the subject.

References

Akintunde, R. O., Shabrina, P., Catete, V., Barnes, T., Lynch, C., & Rutherford, T. (2020, March 23-27). *Data-informed curriculum sequences for a curriculum-integrated game*. In Proceedings of the Tenth International Conference on Learning Analytics & Knowledge (pp. 635-644). Frankfurt, Germany.

Atasay, M. (2018). *Examining students' reflected game functions on mathematical games in an a-didactic milieu* [Doctoral thesis]. Retrieved from YOK National Thesis Center (Order no: 523628).

Aztekin, S., & Taşpınar-Şener, Z. (2015). The content analysis of mathematical modelling studies in Turkey: A meta-synthesis study. *Education and Science*, *40*(178). DOI: 10.15390/EB.2015.4125

Barreto, D., Vasconcelos, L., & Orey, M. (2017). Motivation and learning engagement through playing math video games. *Malaysian Journal of Learning and Instruction 14*(2), 1-21. DOI:10.32890/mjli2017.14.2.1

Başkahya, Z. I. (2021). *The effect of using game-based learning activities in algebra on seventh-grade students' algebra achievement, attitude towards mathematics and opinions about game-based learning activities* (Master's thesis). https://open.metu.edu.tr/handle/11511/93236

Başün, A. R., & Doğan, M. (2020). The effect on academic success and permanence of teaching with game applied in mathematics education. *Journal of Interdisciplinary Educational Research 4*(7), 155-167. https://dergipark.org.tr/en/pub/jier/issue/56808/709176

Bown, M. J., & Sutton, A. J. (2010). Quality control in systematic reviews and meta-analyses. *European Journal of Vascular and Endovascular Surgery*, *40*(5), 669-677. DOI: 10.1016/j.ejvs.2010.07.011

Boz, İ. (2018). The effect of teaching by game to academic success in primary school 4th class mathematics. *Journal of Social Sciences and Education*, *1*(1), 61-75. https://dergipark.org.tr/tr/pub/josse/issue/39178/445982

Bragg, L. (2007). Students' conflicting attitudes towards games as a vehicle for learning mathematics: A methodological dilemma. *Mathematics Education Research Journal*, *19*(1), 29-44.

Callaghan, M. N., Long, J. J., Van Es, E. A., Reich, S. M., & Rutherford, T. (2017). How teachers integrate a math computer game: Professional development use, teaching practices, and student achievement. *Journal of Computer Assisted Learning*, *34*(1), 10-19. DOI: 10.1111/jcal.12209

Chiang, F. K., & Qin, L. (2018). A pilot study to assess the impacts of game-based construction learning, using scratch, on students' multi-step equation-solving performance. *Interactive Learning Environments*, *26*(6), 803-814. DOI: 10.1080/10494820.2017.1412990

Cohrssen, C., & Niklas, F. (2019). Using mathematics games in preschool settings to support the development of children's numeracy skills. *International Journal of Early Years Education*, *27*(3), 322-339. DOI: 10.1080/09669760.2019.1629882

Creswell, J. W. (2017). *Research design: Qualitative, quantitative and mixed method approaches* (S. B. Demir,Trans.). Eğiten Kitap.

Cooper, H., Hedges, L. V. & Valentine, J. C. (2019). Research synthesis as a scientific process. In H. Cooper, L. V. Hedges & J. C. Valentine (Eds.), *The handbook of research synthesis and meta-analysis* (3rd Edition) (pp. 3-18). Russell Sage Foundation.

Çalık, M., & Sözbilir, M. (2014). Parameters of content analysis. *Education and Science, 39*(174), 33-38. DOI: 10.15390/EB.2014.3412.

Demirkaya, C. (2017). *The effect of geometric-mechanic games-based activities on the spatial skills of secondary school students* [Master's thesis]. Retrieved from YOK National Thesis Center (Order no: 503229).

Deng, L., Wu, S., Chen, Y., & Peng, Z. (2020). Digital game-based learning in a Shanghai primary-school mathematics class: A case study. *Journal of Computer Assisted Learning*, *36*(5), 709-717. DOI: 10.1111/jcal.12438

Denzin, N. K., & Lincoln, Y. S. (Eds.). (2011). *The Sage handbook of qualitative research*. SAGE.

Divjak, B., & Tomić, D. (2011). The impact of game-based learning on the achievement of learning goals and motivation for learning mathematics-literature review. *Journal of Information and Organizational Sciences*, *35*(1), 15-30.

Doğan, Z., & Sönmez, D. (2019). Opinions of primary school teachers about the process of using mathematical games in mathematics lessons. *Marmara University Atatürk Education Faculty Journal of Educational Sciences, 50*(50), 96-108. DOI: 10.15285/maruaebd.545417

Dönmez, A. (2017*). How play supported learning environment affect the 3rd grade student's metacognitive awareness and metacognitive strategy usage skills on number patterns*? [Master's thesis]. Retrieved from YOK National Thesis Center (Order no: 472227).

Ergül, E. & Doğan, M. (2019, December 12-13). *The effects of using games for "rounding off the nearest ten" on student achievement in the teaching of mathematics*. In 6th international Yildiz Social Sciences Congress (pp. 1878-1888). İstanbul, Turkey.

Ergül, E. (2021). *Game-based teaching of mathematics* [Master's thesis]. Retrieved from YOK National Thesis Center (Order no: 676485).

Erkin-Kavasoğlu, B. (2010). *The effects of game-based teaching of probability on the achievement of mathematics lessons students of 6th, 7th, 8th grades* [Master's thesis]. Retrieved from YOK National Thesis Center (Order no: 279607).

Es-Sajjade, A., & Paas, F. (2020). Educational theories and computer game design: Lessons from an experiment in elementary mathematics education. *Educational Technology Research and Development*, *68*(5), 2685-2703. DOI: 10.1007/s11423-020-09799-w

Eyster, T. (2017). *Serious mathematics games bolster self-concept and self-efficacy in women learners* [Doctoral theses]. Retrieved from ProQuest Thesis Center (Order no: 10284615).

Foster, R. (2004). Crazy bones. *Mathematics Teaching*, 187, 17.

Fouze, A. Q., & Amit, M. (2018). Development of mathematical thinking through integration of ethnomathematics folklore game in math instruction. *Eurasia Journal of Mathematics, Science and Technology Education*, *14*(2), 617-630. DOI: 10.12973/ejmste/80626

Galarza, P. D. (2019). *The effects of mathematical game play on the cognitive and affective development of pre-secondary students* [Doctoral theses]. Retrieved from ProQuest Thesis Center.

Galiç, S. (2020). *Investigation of the effects of mathematics activities enriched with game elements on students' success, attitude and motivation* [Master's thesis]. Retrieved from YOK National Thesis Center (Order no: 646615).

Golafshani, N. (2003). Understanding reliability and validity in qualitative research. *The Qualitative Report*, *8*(4), 597-607.

Gough, D., & Thomas, J. (2016). Systematic reviews of research in education: Aims, myths and multiple methods. *Review of Education, 4*(1), 84-102. DOI: 10.1002/rev3.3068

Graceota, A., & Slamet, I. (2021, March). *Mathematics game as interactive learning media in Covid-19 Pandemic era.* AEVEC 2020 Vol. 1808, In Journal of Physics: Conference Series (pp. 012041). IOP Publishing.

Gür, H., & Kobak-Demir, M. (2016). The views of the teacher candidates about the project of game-based mathematics learning laboratory. *Necatibey Faculty of Education Electronic Journal of Science and Mathematics Education*, *10*(1), 415-438.

Higgins, J. P., Thomas, J., Chandler, J., Cumpston, M., Li, T., Page, M. J., & Welch, V. A. (Eds.). (2019). *Cochrane handbook for systematic reviews of interventions*. John Wiley & Sons.

Jones, M. G., & Brader-Araje, L. (2002). The impact of constructivism on education: Language, discourse, and meaning. *American Communication Journal*, *5*(3), 1-10. https://ac-journal.org/journal/vol5/iss3/special/jones.pdf

Joung, E., & Byun, J. (2020). Content analysis of digital mathematics games based on the NCTM content and process standards: An exploratory study. *School Science and Mathematics*, *121*(3), 127-142. DOI: 10.1111/ssm.12452

Kaleli-Yılmaz, G. (2015). Analysis of technological pedagogical content knowledge studies in Turkey: A meta-synthesis study. *Education and Science*, *40*(178), 103-122. DOI: 10.15390/EB.2015.4087

Kalish, M. (2017). Multisensory mathematical gaming with the Energizer Bunny. *On the Horizon*. *25(4)*, 260-266.

Karamert, Ö. (2019). *The effect of gamification on the success and attitude of the 5th grade mathematics course* [Master's thesis]. Retrieved from YOK National Thesis Center (Order no: 590306).

Ke, F. (2014). An implementation of design-based learning through creating educational computer games: A case study on mathematics learning during design and computing. *Computers & Education*, *73*, 26-39. DOI: 10.1016/j.compedu.2013.12.010

Kiili, K., Ojansuu, K., Lindstedt, A., & Ninaus, M. (2018). Exploring the educational potential of a game-based math competition. *International Journal of Game-Based Learning (IJGBL), 8*(2), 14-28. DOI:10.4018/IJGBL.2018040102

Koç-Deniz, H. (2019). *The effect of game and activity supported flipped classroom model on students` achievement in problem solving skill and reflective thinking skill based on problem solving in mathematics course* [Doctoral thesis]. Retrieved from YOK National Thesis Center (Order no: 606454).

Kokandy, R. A. (2021). *The effect of digital game-based learning on students' motivation in math classes* [Doctoral thesis]. Northern Illinois University, USA.

Koneva, B., & Shabanova, M. (2021). Board game "making financial decisions" in the system of teaching the mathematical foundations of financial literacy. *Математика и Информатика*, *64*(2), 173-181.

Kondratieva, M., & Freiman, V. (2011, June 10-14). Virtual mathematics marathon: A mathematical game for all children. *Proceedings of the 2011 Annual Meeting of The Canadian Mathematics Education Study Group* (pp-169-170). Memorial University of Newfoundland.

Lee, H. K., & Choi, A. (2020). Enhancing early numeracy skills with a tablet-based math game intervention: A study in Tanzania. *Educational Technology Research and Development*, *68*(6), 3567-3585.

Liang, Y., Zhang, L., Long, Y., Deng, Q., & Liu, Y. (2019). Promoting effects of RtI-based mathematical play training on number sense growth among low-SES preschool children. *Early Education and Development*, *31*(3), 335-353. DOI: 10.1080/10409289.2019.1664261

Lindström, P., Gulz, A., Haake, M., & Sjödén, B. (2011). Matching and mismatching between the pedagogical design principles of a math game and the actual practices of play. *Journal of Computer Assisted Learning*, *27*(1), 90-102. DOI: 10.1111/j.1365-2729.2010.00380.x

Machaba, M. M. (2019). Mathematical games as tool for mathematics teaching in the foundation phase. *e-BANGI*, *16*(5), 1-8.

Marange, T., & Adendorff, S. A. (2021). The contribution of online mathematics games to algebra understanding in Grade 8. *Pythagoras*, *42*(1), 8.

McIntosh, N. O. (2018). *The impact of gamification on seventh graders' academic achievement in mathematics* [Doctoral thesis]. Retrieved from ProQuest Thesis Center (Order no: 10974660).

Nabie, M. J. (2008). *Cultural games in Ghana: Exploring mathematics pedagogy with primary school teachers* [Doctoral thesis]. Retrieved from ProQuest Thesis Center (Order no: 107939).

Nfon, N. F. (2018). The use of mathematical games and secondary school students' achievement in mathematics in Fako Division, South West Region of Cameroon. *Journal of Education and Entrepreneurship*, *5*(1), 20-31. DOI: 10.26762/jee.2018.40000009

Oakley, A. (2012). Foreword. In D. Gough, S. Oliver, & J. Thomas (Eds.), *An introduction to systematic reviews* (pp. vii-x). SAGE.

Oldfield, B. J. (1991). Games in the learning of mathematics: 1: A classification. *Mathematics in School*, *20*(1), 41-43. http://www.jstor.org/stable/30214754

Pehlivan, F. (2020). *The impact of the gamification on mathematic success, motivation and learning strategies in the flipped classrooms* [Master's thesis]. Retrieved from YOK National Thesis Center (Order no: 633113).

Pilten, P., Pilten, G., Divrik, R., & Divrik, F. (2017). Evaluation of mathematical game design skills of pre-service classroom teachers. *International Electronic Journal of Elementary Education*, *10*(2), 255-264. DOI: 10.26822/iejee.2017236120

Prince, M. (2004). Does active learning work? A review of the research. *Journal of Engineering Education*, *93*(3), 223-231. doi.org/10.1002/j.2168-9830.2004.tb00809.x

Punch, K. (2005). *Introduction to Social Research: quantitative and qualitative approaches*. London: Sage Publications.

Rawansyah, R., Pramudhita, A. N. & Pramitarini, Y. (2021, February). *Enhancing student interest in learning through the development of serious mathematics games*. The 2nd Annual Technology Applied Science and Engineering Conference (ATASEC 2020) Vol. 1073. In IOP Conference Series: Materials Science and Engineering (pp. 1-6). Malang, Indonesia: IOP Publishing. doi:10.1088/1757-899x/1073/1/012064

Rondina, J. Q., & Roble, D. B. (2019). Game-based design mathematics activities and students' learning gains. *The Turkish Online Journal of Design Art and Communication*, *9*(1), 1-7. https://dergipark.org.tr/tr/download/article-file/596837

Russo, J., Bragg, L. A., & Russo, T. (2021). How primary teachers use games to support their teaching of mathematics. *International Electronic Journal of Elementary Education*, *13*(4), 407-419. https://www.iejee.com/index.php/IEJEE/article/view/1302

Sandelowski, M., Barroso, J., & Voils, C. I. (2007). Using qualitative meta summary to synthesize qualitative and quantitative descriptive findings. *Research in Nursing & Health*, *30*(1), 99-111. DOI: 10.1002/nur.20176

Shabrina, P., Akintunde, R. O., Maniktala, M., Barnes, T., Lynch, C., & Rutherford, T. (2020, March 23-27). *Peeking through the classroom window: a detailed data-driven analysis on the usage of a curriculum integrated math game in authentic classrooms*. In Proceedings of the Tenth International Conference on Learning Analytics & Knowledge (pp. 625-634). Frankfurt, Germany.

Silva, J. N. (2011). On mathematical games. *BSHM Bulletin: Journal of the British Society for the History of Mathematics*, *26*(2), 80-104. DOI: 10.1080/17498.430.2011.560511

Skillen, J., Berner, V. D., & Seitz-Stein, K. (2018). The rule counts! Acquisition of mathematical competencies with a number board game. *The Journal of Educational Research*, *111*(5), 554-563. DOI: 10.1080/00220671.2017.1313187

Sönmez, D. (2018). *The use of mathematical games to improve students' affective awareness in primary school mathematics teaching* [Master's thesis]. Retrieved from YOK National Thesis Center (Order no: 510730).

Stanton, J. M. (2017). *Effects of Minecraft as an instructional tool for teaching geometry at the fifth-grade level* [Doctoral thesis]. Retrieved from ProQuest Thesis Center (Order no: 10262277).

Tärning, B., & Silvervarg, A. (2019). "I didn't understand, I′m really not very smart"—How design of a digital tutee's self-efficacy affects conversation and student behavior in a digital math game. *Education Sciences*, *9*(3), 197. DOI: 10.3390/educsci9030197

Trujillo, K., Chamberlin, B., Wiburg, K., & Armstrong, A. (2016). Measurement in learning games evolution: Review of methodologies used in determining effectiveness of math snacks games and animations. *Technology, Knowledge and Learning*, *21*(2), 155-174.

Turgut, S., & Temur, Ö. D. (2017). The effect of game-assisted mathematics education on academic achievement in Turkey: A meta-analysis study. *International Electronic Journal of Elementary Education*, *10*(2), 195-206. DOI: 10.26822/iejee.2017236115

Tükle, H. (2020*). The effect of educational escape room game designed for mathematics course on students' achievement and students' opinions about escape room game* [Master thesis]. Retrieved from YOK National Thesis Center (Order no: 636349).

Türker, A., & Dündar, E. (2020). The opinions of high school teachers on distance learning which is carried out through EBA (Educatıonal Informatıcs Network) during Covid-19 pandemic period. *Milli Eğitim Dergisi, 49*(1), 323-342.

Türker, K. N., & Arslan, S. (2021). Examination of the studies related to teaching mathematics through games in Turkey. *Turkish Journal of Mathematics Education*, *2*(2), 110-132.

Türkmen. G. P. (2017). *The effect of gamification methodology on students' achievements and attitudes towards mathematics* [Master's thesis]. Retrieved from YOK National Thesis Center (Order no: 490555).

Uğurel, I., & Moralı, S. (2008). The interaction of mathematics & game. *Gazi University Journal of Gazi Education Faculty*, *28*(3), 75-98. https://dergipark.org.tr/tr/pub/gefad/issue/6746/90703

Usta, N., Işık, A. D., Şahan, G., Genç, S., Taş, F., Gülay, G.,... Küçük, K. (2017). The opinions of pre-service teachers on the usage of games in mathematics teaching. *International Journal of Social Sciences and Education Research, 3*(1), 328-344. DOI: 10.24289/ijsser.270771

Van de Walle, J. A., Karp, K. S., & Bay-Williams, J. M. (2016). *Elementary and middle school mathematics: Teaching developmentally*. Pearson Education UK.

Watson-Huggins, J. (2018). *An experimental study on the effects of a gamified software intervention in mathematics achievement among sixth grade students* [Doctoral thesis]. Retrieved from ProQuest Thesis Center (Order no: 13820081).

Wells, D. (2012). *Games and mathematics: Subtle connections.* Cambridge University Press.

White, K., & McCoy, L. P. (2019). Effects of game-based learning on attitude and achievement in elementary mathematics. *Networks: An Online Journal for Teacher Research*, *21*(1), 5.

Winicki-Landman, G. (2008). Up and down: A stimulating mathematical game. *Mathematics in School*, *37*(4), 38-39.

Wouters, P., & Van Der Meulen, E. S. (2020). The role of learning styles in game-based learning. *International Journal of Game-Based Learning (IJGBL)*, *10*(1), 54-69. DOI: 10.4018/IJGBL.2020010104

Yılmaz, S. (2019). *The effect of using teaching with play method on attitude and success in gaining the problem-solving skills in primary mathematics course* [Master Thesis]. Retrieved from YOK National Thesis Center (Order no: 555809).