Journal of Educational Technology & Online Learning
Volume 4 | Issue 2 | 2021
http://dergipark.org.tr/jetol

The effect of gamification on young mathematics learners' achievements and attitudes

Önder Karamert [a] *, Aslıhan Kuyumcu Vardar [b]

[a] Gazi University, Turkey.
[b] Düzce University, Turkey.

Suggested citation: Karamert, Ö. & Kuyumcu Vardar, A. (2021). The effect of gamification on young mathematics learners' achievements and attitudes. *Journal of Educational Technology & Online Learning*, 4(2), 96-114.

Article Info

Keywords:

Gamification
Educational technology
Gamification elements
Mathematics education

Research Article

Abstract

This study aims to investigate the effect of gamification on fifth-grade students' academic achievements and attitudes towards mathematics course. For this purpose, the teaching process of the "fractions" as a subject of the mathematics course is equipped with gamification elements. The quasi-experimental design is preferred as the research design. Achievement test and attitude scale were used as data collection instruments. The participants of the study consisted of fifth-grade students (n = 46). The Pyramidal Design Model was preferred as the gamification design model in this study. Elements of this model were adapted to the class level of participants in this research. As a result of the study, a remarkable statistical difference was observed in the achievement test in favor of the experimental group. However, no major difference was observed in the attitude scale results. This study contains suggestions for the educational use of gamification based on research findings.

1. Introduction

The technological opportunities of the 21st century have led to differentiation in the learning profiles of today's students (Balakrishnan & Lay, 2016; Eleyyan, 2021; Liu et al., 2020; Ndibalema, 2020). The learning profiles have differentiations according to learners' ages (Avcu & Er, 2020; Cevher & Yıldırım, 2020). However, educational games are considerable for every learning profile (Garber Jr et al., 2018; Gök, 2020; Ruiperez-Valiente et al., 2020; Umay, 2002). In addition, educational contributions of games and game-like formations have been proven by researchers, especially for primary and secondary school students (Asan & Çeliktürk-Sezgin, 2020; Eltem & Berber, 2020; Uğurel & Moralı, 2008; Yaşar, 2018). Accordingly, teachers should choose contemporary teaching methods and techniques for these different profiles increase to students' interest in teaching processes (Kiryakova et al., 2014). One of these game and game-like methods that aim to have a more enjoyable interaction for the participants in their work (Wood & Reiners, 2015) is "gamification" (Lee & Hammer, 2011). Gamification aims to improve participants' personal qualities such as permanence, creativity, and flexibility by targeting their motivations (Lee & Hammer, 2011).

Gamification can be part of student's educational lives in the years to come. It is thought that gamification can be successful in directing students' motivations towards learning activities and this situation can positively contribute to students being successful individuals in their academic and social lives (Lee & Hammer, 2011). Accordingly, the studies show that gamification affects students' academic achievement

* Corresponding author: Gazi University, Turkey.
e-mail addresses: onderkaramert@gmail.com

Doi: http://doi.org/10.31681/jetol.904704
Received 28 Mar 2021; Revised 14 May 2021; Accepted 19 May 2021;
ISSN: 2618-6586 .

and attitudes (Barata et al., 2013; De-Marcos et al., 2014; Dominguez et al., 2013; Hanus & Fox, 2015; Mekler et al., 2013; O'Donovan et al., 2013). When the related literature (Kim & Castelli, 2021; Klock et al., 2020; Lister, 2015; Manzano-Leon et al., 2021; Swacha, 2021) is reviewed, it is seen that gamification can be used in the fifth-grade mathematics course. From this point of view, it was thought that gamification might have an effect on students' performance and attitudes towards the course. Thus, this research has been conducted in this direction. Therefore, this study performed to be an answer for the following research questions:

- Does Gamification affect fifth-grade students' academic achievement in mathematics?
- Does Gamification affect fifth-grade students' attitude towards the mathematics course?

2. Theoretical Framework

2.1. Mathematics Education and Games

Throughout history, games that take place in human life are not contradictory to mathematics (Uğurel & Moralı, 2008). According to Umay (2002, p. 280): "Games are mostly mathematics and mathematics is completely game". Ratiocination, creative thinking, making inferences and similar interactions in the basic structure of mathematics are seen in the structure of games. This situation makes it convenient to include games in the mathematics teaching process (Hacısalihoğlu-Karadeniz, 2017; Ke & Clark, 2020; Tokac et al., 2019).

Using games in the mathematics teaching process is one of the methods that can assist students to learn mathematics with enjoyment (Beyhan & Tural, 2007). The enjoyable world of games; positively affects students' attitudes towards mathematics, learning motivation, and active participation in the course. In this way, learning environments become interesting for students (Deng et al., 2020; Gök, 2020; Moon & Ke, 2020).

2.2. What is Gamification?

The concept of "gamification", which has become popular since 2010, is revealed itself in the business world, health, and education areas (Deterding et al., 2011). There are different definitions of gamification in the literature.

Deterding et al. (2011) defined gamification as the inclusion of game design materials in non-game environments. Likewise, Dominguez et al. (2013) defined gamification as including game elements in a non-game implementation to increase user experience and interest. In addition, Kim & Lee (2015) defined gamification as applying game design to the non-game processes.

When the definitions in the Turkish studies are examined, Bozkurt & Genç-Kumtepe (2014) described gamification as the implementations regarding the game philosophy that increase individual motivation and convert the process interesting for the participants. Furthermore, Sezgin et al. (2018) defined gamification as it is the planned addition of game elements to processes that do not have game factors. In addition, Gökkaya (2014) defined gamification as an educational platform that aims to internalise the extrinsic motivations of individuals and rewards along with feedback. When the definitions were examined, gamification can be defined as equipping non-game processes with game design elements.

There are approaches in the literature that are confused with gamification. The first of these is game-based learning. The use of the expression "game" in gamification, just like in game-based learning, may cause this similar perception problem. Unlike game-based learning; in gamification, "game" finds its place not as an actor but as a philosophy. Therefore, gamification and game-based learning are different and should not be confused (Bozkurt & Genç-Kumtepe, 2014; Sezgin et al., 2018).

2.3. Gamification in Education

Although gamification is a new term that emerged recently, it has been used in the educational areas, the economy, marketing, advertising, and production sectors (Yıldırım & Demir, 2014). One of the main goals of gamification is to increase participants' motivation and assist them to have positive experiences in life events (Kim & Lee, 2015). Most students do not view traditional classroom activities at school as enjoyable experiences (Dursun & Dede, 2004). Therefore, it is thought that the enjoyable world of gamification can assist to overcome the motivation and contribution problems of today's education systems (Lee & Hammer, 2011).

Education researchers have taken a keen interest in gamification (Dominguez et al., 2013). Lee & Hammer (2011) have described assembling education and game elements as combining peanut butter with chocolate to create a wonderful taste. Studies show that gamification can make a positive contribution to the education process (Kim & Castelli, 2021; Klock et al., 2020; Lister, 2015; Manzano-Leon et al., 2021; Swacha, 2021). In addition, the adaptation of gamification to learners is considered a remarkable point in the use of gamification in education. Thus, it will be easier for learners with different abilities to participate effectively in the learning environment (Sezgin et al., 2018). Students who increase their active participation can establish new bonds to understand their learning process. This situation can encourage students to participate in educational processes more effectively (Lee & Hammer, 2011). With this respect, it was thought that gamification could also be effective for fifth-grade mathematics education and this study's aim was determined with this mind.

3. Methodology

3.1. Research Design

The matching-only pretest-posttest control group quasi-experimental design, which is one of the experimental research models was preferred in this study. In this design, experimental and control groups are tried to be matched based on a specific variable (Büyüköztürk et al., 2018; Fraenkel et al., 2011).

The purpose of the quasi-experimental design method is to determine the amount of change between the experimental and the control group (Büyüköztürk et al., 2018). This method aims to divide the students into two equal groups based on their academic averages related to the mathematics lesson. Assigning process of those students to the experimental and control groups was carried out by matching (Fraenkel et al., 2011). At the beginning and the end of the process, the academic achievement test on the subject of the mathematics lesson of "fractions" was applied to both groups. In addition, the attitude scale towards the mathematics lesson was studied as pre-test and post-test to both groups. The experimental design of this study is shown in Table 1.

Table 1.

The matching-only pretest-posttest control group design

Group		Pre-Test	Process	Post-Test
E	M	O_1	X	O_3
C	M	O_2	C	O_4

E: Experimental group.
C: Control group.
M: Matching according to academic achievement in mathematics.
O_1: Experimental group pre-test.
O_2: Control group pre-test.
X: Gamified teaching process.
C: Non-gamified teaching process.

O_3: Experimental group post-test.
O_4: Control group post-test.

Table 1 shows the processes in the quasi-experimental designs used in the research. The experimental and control groups teaching process was performed based on the Fifth-Grade Mathematics Curriculum (Milli Eğitim Bakanlığı [Ministry of National Education] [MEB], 2018). Unlike the control group, the teaching process in the experimental group was supported by gamification elements. By this way, gamification elements were performed in the experimental group during six weeks of the experimental process. No features and items related to gamification were included in the teaching process of the control group. Both groups were tested with pre-test and post-test in terms of academic achievement and attitudes towards mathematics.

3.2. Study Group and Ethical Considerations

This research consists of fifth-grade students of a school in the West Black Sea region of Turkey. Participants are divided into two equal groups in terms of academic achievement and class size (Table 2). Experimental and control groups were determined by random selection between two classes. Both groups were consisting of 23 students.

The research process was carried out by following appropriate ethical merits (Lodico et al., 2010). Participation in research occurred on a voluntary basis and students had the right to leave the process whenever they wanted. Written consents for the research have been obtained from the relevant institutions. Since the participants were under 18 years of age, written consent forms of the students were received from the parents. In addition, students and parents were informed that their personal information regarding the research data will be kept confidential and the collected data will only be used for this research.

3.3. Data Collecting Tools

The first author of this study prepared the academic achievement test used in this study. In the test development process, multiple-choice test development steps specified by Turgut & Baykul (2015) were followed.

The application of the 32-item trial form, of which items were written in accordance with the subject of “fractions”, was performed in the 2017-2018 academic year. After the trial form results obtained, expert opinions were requested to assess the propriety of the test items. For this purpose, six experts who are researchers in Curriculum & Instruction and Mathematics Education were consulted for their opinions. The test was revised according to the experts’ opinions. According to the statistical analysis results of this 24-item form; the test variance was 33.39 and the standard deviation value was 5.77. The Cronbach Alpha reliability coefficient and the average difficulty value were measured respectively as .87 and .59. The average discrimination power was .66.

Students’ attitudes are tested with the “Attitude Scale Towards Mathematics” developed by Önal (2013). This scale aims to determine secondary school students’ attitudes towards mathematics lessons. The scale consists of 21 Likert-type items rated between Strongly Agree (5) and Strongly Disagree (1).

In line with the factor analysis results applied by the researcher who created the scale, the scale items were divided into 4 subcategories (Interest, Anxiety, Study and Necessity). According to validity and reliability analysis, the variance explained by the scale constitutes 55.12% of the total variance. In the reliability calculations of the scale, the Cronbach Alpha coefficient was determined as .90 (Önal, 2013).

3.4. Data Analysis

In the analysis process of this study, the data collected with the achievement test and attitude scale were analysed. In the process of creating the academic achievement test, the “Iteman” item analysis program was used to perform the item analysis. Also, the SPSS Software (The Statistical Packet for the Social Sciences) was used in the analysis of the data collected from the experimental process.

Considering the size of classes that are less than 30, non-parametric tests “Mann-Whitney U” and “Wilcoxon Signed Rank Test” were decided to be used for analysis. “Wilcoxon Signed Rank Test” and “Mann-Whitney U” are non-parametric tests used in behavioral and social sciences when data are not normally distributed or the sample size is less than 30 (Gravetter et al., 2020; Kraska-Miller, 2013; Pagano, 2012; Pett, 2015; Salkind, 2016; Siegel, 1956; Sokal & Rohlf, 2009; Turgut, 2014). The Wilcoxon Signed Rank Test is used for dependent groups and Mann-Whitney U Test is used for independent groups in order to examine the statistical difference (Kraska-Miller, 2013; Pagano, 2012; Salkind, 2016; Turgut, 2014). Accordingly, both tests were used in the analysis process of this study.

3.5. Gamification Design in This Research

Pyramidal Design Model, which Werbach & Hunter (2012) developed, is preferred as the gamification design model of the research. Considering Pyramidal Design Model’s elements were adapted fifth-grade students’ level. This model was considered appropriate in terms of participations’ level and the selected subject. Elements of the Pyramidal Design Model are shown in Figure 1.

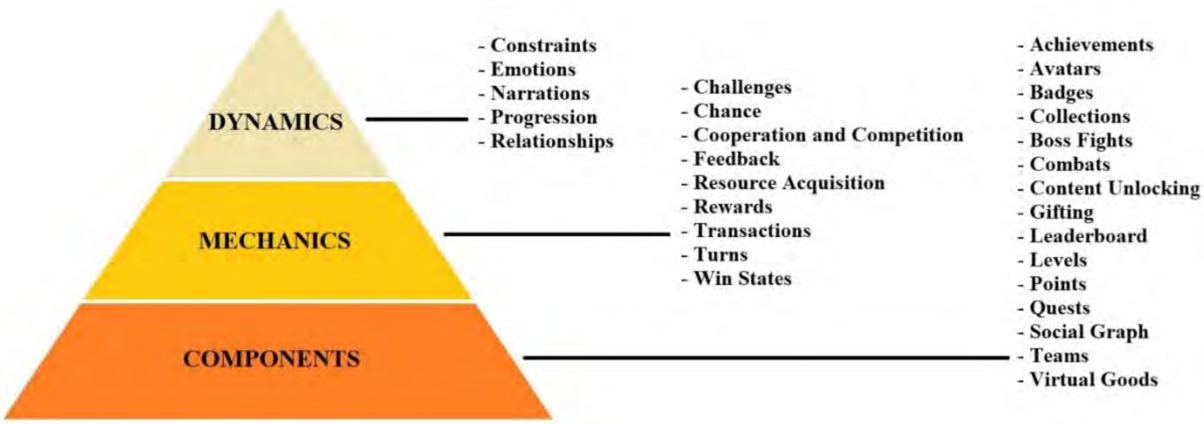

Fig. 1. Pyramidal design model

As shown in Figure 1, there is no obligation to use all elements of dynamics, mechanics, and components in gamification designs. The elements of this model can be determined according to the characteristics of the educational environment (Bozkurt & Genç-Kumtepe, 2014; Werbach & Hunter, 2012). Accordingly, grade level and school characteristics were taken into consideration.

It can be said that the “Do not worry, try again!” idea is the main idea of the gamified processes. (Werbach & Hunter, 2012). This idea was intended to extend into the process. In addition, the gamification process was designed and implemented that each student could gain affective, cognitive, and social gains from the process (Lee & Hammer, 2011). In this direction, the elements were adapted and coordinated. Considering that the study will be conducted at this age level, interpersonal competition is not included in the system. Accordingly, all situations that could lead to the “Loser” phenomenon were excluded from the process. Thus, the “Leaderboard” element, in which the students are ranked according to their general scores, is not included in this research. However, instead, a new element called “Progress Map” is included in the process. The Progress Map element is formed by combining the “Narrations” and “Progression” elements. “Progress Map” and other elements that were selected and adapted for the process are shown in Figure 2.

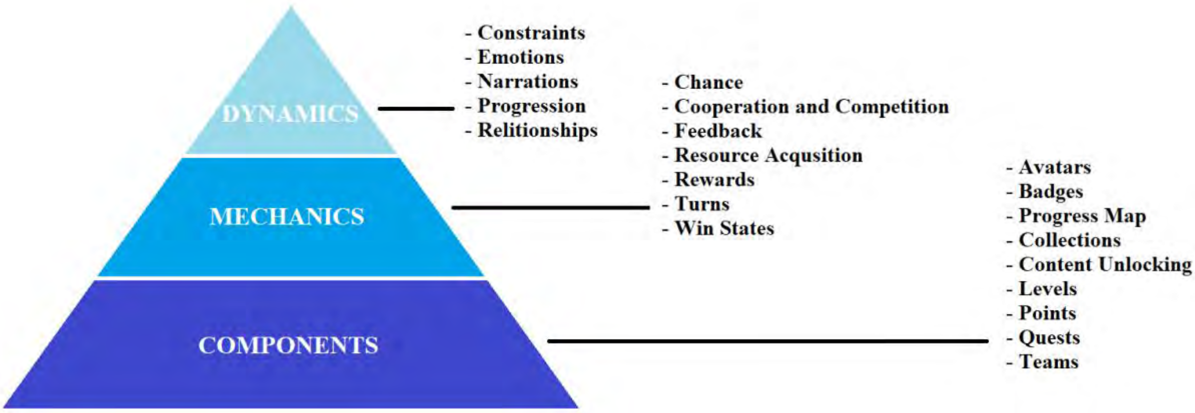

Fig. 2. Gamification elements of this research

Figure 2 shows the gamification elements used in the study. Considering that the elements will be used for the fifth-grade level, the selected game elements are not given in the digital environment and have been concretised as much as possible. It is thought that this situation will increase the usefulness of the elements for fifth-grade students.

3.6. Implementation Process

In order to maintain an equal teaching environment, this study's first author decided to be the mathematics teacher of both groups. The application process started with pre-tests of both groups. Achievement test and attitudes scale were applied to the experimental and control groups to determine their prior knowledge of Fractions lesson and attitudes towards the mathematics course. The first author was also the exam supervisor in the testing processes. Students were informed about the implementation details of the testing process (pencil, eraser, test period, etc.).

The experimental implementations based on researching process were carried out for six weeks in five-course hours per week. In both groups, the teaching process was performed based on the Fifth-Grade Mathematics Curriculum (MEB, 2018). Contrary to the procedure in the control group, the experimental group's teaching process included gamification components that were modified and tailored for the fifth-grade level. The visuals containing explanations for some of these elements are shown in Figure 3, Figure 4 and Figure 5.

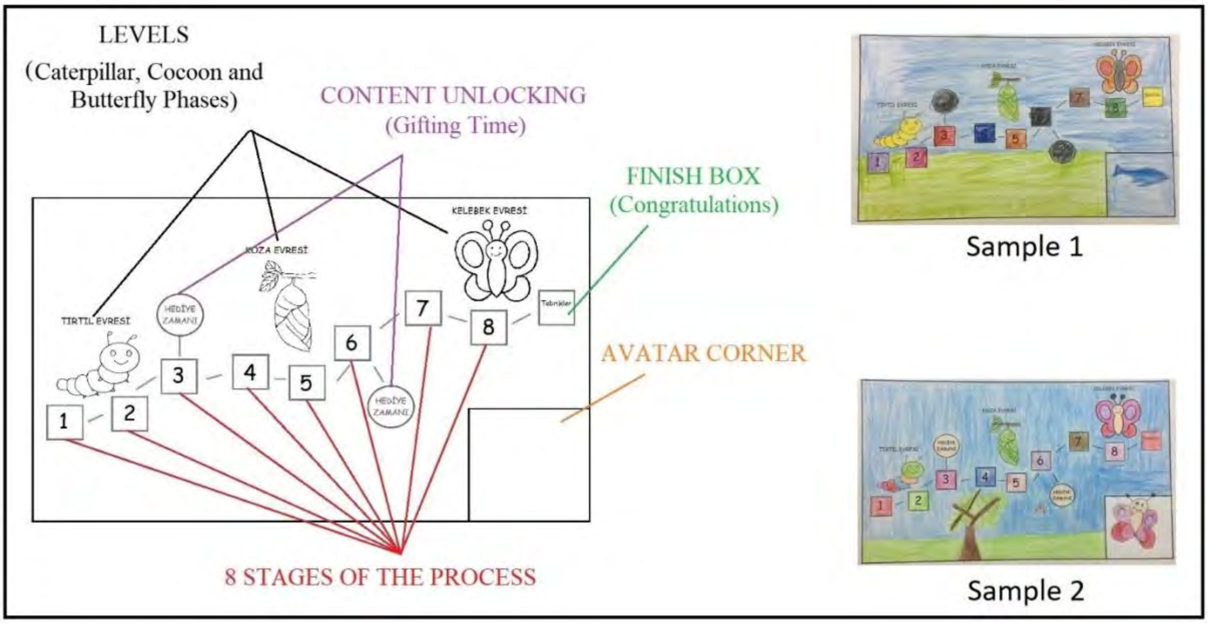

Fig. 3. Progress map

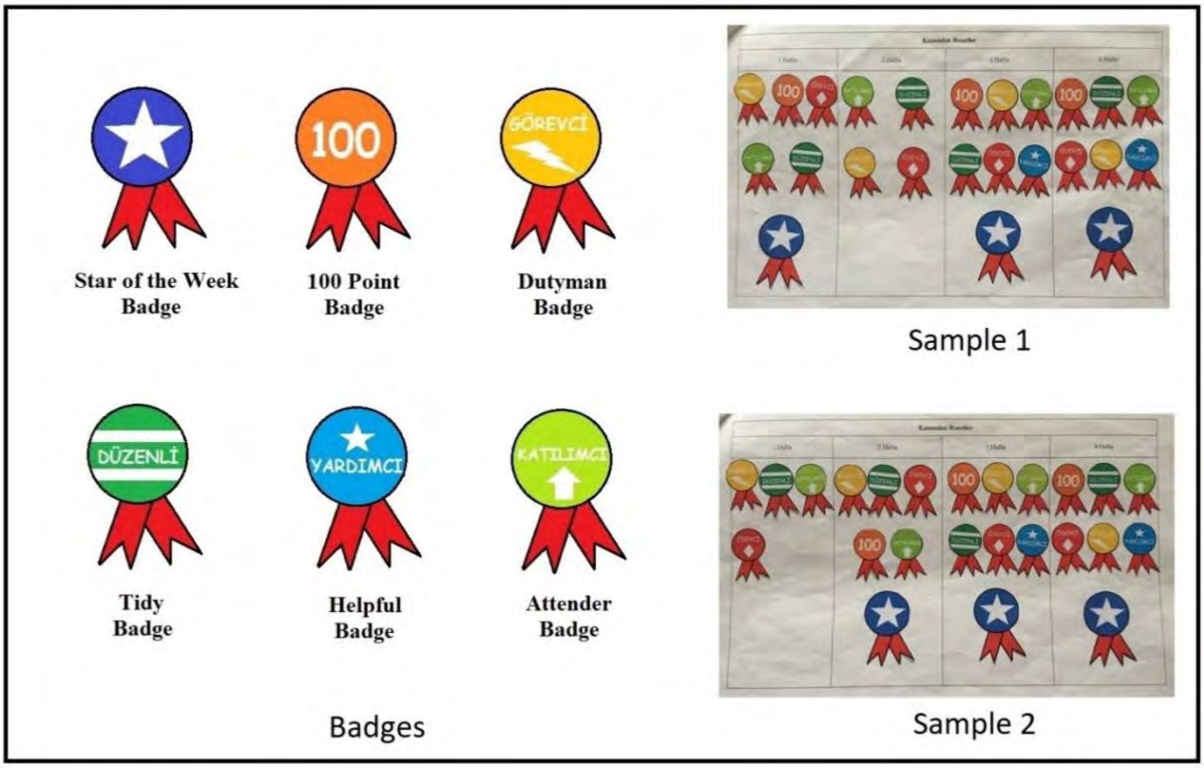

Fig. 4. Badges and collections

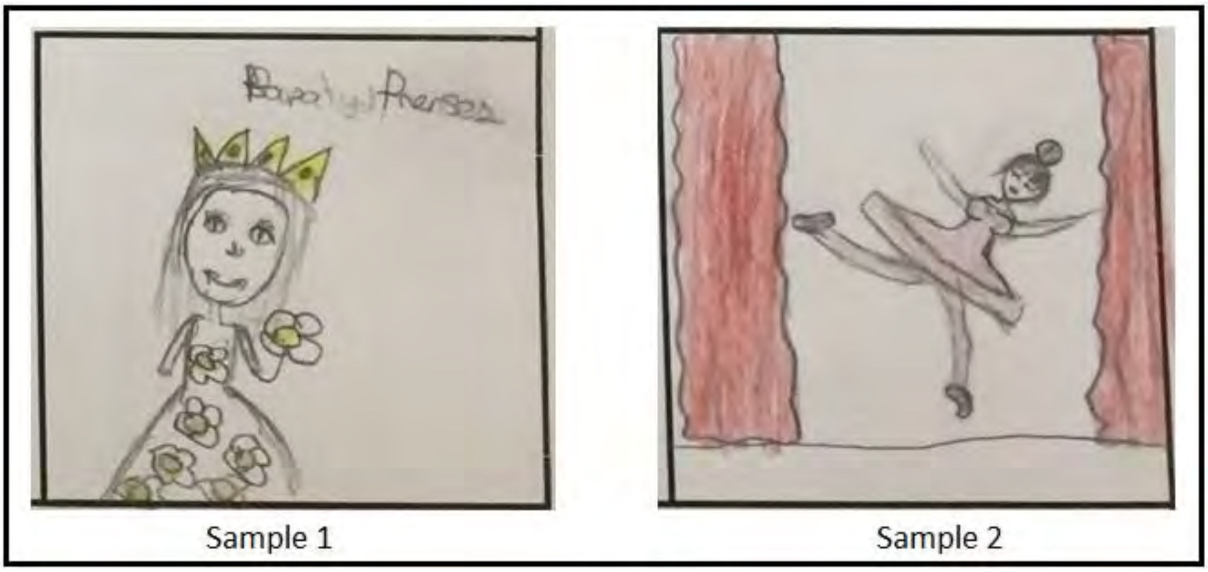

Fig. 5. Avatars

Figure 3, Figure 4, and Figure 5 show visuals of the gamification elements that were used in the research. In the first weeks of the application, the students were informed about these elements. After this stage, the progress maps were delivered to each student in the experimental group. And then, each student was requested to customise their maps and identify their avatars. Badges are given to students in the last lesson of each week, according to their weekly achievements. Following the weekly feedbacks, information was given about the next week's tasks and homework. In this way, the gamified process continued for six weeks from the first week to the last week, adhering to the Fifth-Grade Mathematics Curriculum (MEB, 2018) and using the defined gamification elements.

4. Findings

4.1. Pre-Test and Post-Test Values of Achievement Test Scores of Experimental and Control Group Students

Before and after the gamified process, an academic achievement test was applied to the participants. Score statistics for these tests are shown in Table 2.

Table 2.

Pre-test and post-test values of achievement test scores of experimental and control groups

	Pre-test			Post-test		
Group	**N**	$\bar{X}$	**S**	**N**	$\bar{X}$	**S**
Experimental	23	27.89	6.93	23	60.14	19.21
Control	23	27.17	10.87	23	47.10	19.92

Table 2 shows the pre-test and post-test statistics of the experimental and control groups. According to these statistics, the achievement test pre-test mean scores of the experimental and control groups were found to be close and the statistical significance of this proximity was tested. With respect to the analysis results, the means of the two groups were statistically verified. By this mean, it can be said that the experimental research conditions were satisfied. At the end of the process, the statistical significance of the difference among the post-test mean scores between the experimental and control groups was analysed. Analysis results regarding all data are presented below.

4.2. Examination of the Relationship Between Achievement Test Scores of Experimental and Control Group Students

The Mann Whitney U Test was used to statistically analyse the difference between the achievement test scores of the experimental and control groups in this study. Test results are presented in Table 3.

Table 3.

Mann Whitney U Test results of achievement test scores according to experimental and control groups

Group	N	Rank Mean	Rank Sum	U	P
Experimental	23	28.78	662.00	143.00	.007*
Control	23	18.22	419.00		
Total	46				

*$p < .05$.

Table 3 shows the results of the Mann Whitney U Test of achievement test scores. Accordingly, as a result of the six weeks experimental study, it was seen that there was a significant difference between the achievement test scores of the experimental and control groups (U = 143.00, p <.05). Considering the mean ranks, it is understood that the achievement test scores of the experimental group are higher than the achievement test scores of the control group. Based on this finding, it can be said that gamification is effective in increasing students' achievement in the mathematics course.

4.3. Examination of the Relationship Between Experimental Group Students' Pre-Test and Post-Test Achievement Test Scores

The Wilcoxon Signed Rank Test was used to statistically analyse the difference between the achievement test scores of the experimental group. Test results are presented in Table 4.

Table 4.

Wilcoxon Signed Rank Test results of achievement test scores according to experimental group

Post-Test - Pre-Test	N	Rank Mean	Rank Sum	Z	P
Negative Ranks	0	.00	.00	4.20	.000*
Positive Ranks	23	12.00	276.00		
Equal	0	-	-		
Total	23				

*$p < .05$.

Table 4 shows the results of the Wilcoxon Signed Rank Test of the experimental group achievement test scores. Analysis results indicated that the experimental group students' achievement test scores have a significant difference between the pre-test and post-test scores (Z = 4.20, p <.05). Considering the results that are shown in Table 4, it is understood that the difference is in favour of the positive ranks. According to these results, it can be said that gamification has an important effect on increasing students' achievement in the mathematics course.

4.4. Examination of the Relationship Between Control Group Students' Pre-Test and Post-Test Achievement Test Scores

The Wilcoxon Signed Rank Test was used to statistically analyse the difference between the achievement test scores of the control group. Test results are presented in Table 5.

Table 5.

Wilcoxon Signed Rank Test results of achievement test scores according to control group

Post-Test - Pre-Test	**N**	**Rank Mean**	**Rank Sum**	**Z**	**P**
Negative Ranks	0	.00	.00	4.20	.000*
Positive Ranks	23	12.00	276.00		
Equal	0	-	-		
Total	23				

*$p < .05$.

Table 5 shows the results of the Wilcoxon Signed Rank Test of the control group achievement test scores. Analysis results show a significant difference occurred in the control group students' achievement test scores (Z = 4.20, p <.05). Considering Table 5, it is understood that the difference is in favour of the positive ranks. According to these results, it can be said that the control group students' achievement increased without gamification elements.

4.5. Pre-Test and Post-Test Values of Attitude Scale Scores of Experimental and Control Group Students

The attitude scale was applied to the experimental and control group students to determine their attitude scores towards the mathematics course. This scale score statistics are presented in Table 6.

Table 6.

Attitude scale pre-test and post-test results of experimental and control groups

	Pre-test			**Post-test**		
Group	**N**	$\bar{X}$	**S**	**N**	$\bar{X}$	**S**
Experimental	23	3.97	.71	23	3.98	.87
Control	23	4.19	.64	23	4.11	.69

Table 6 shows the attitude scale pre-test and post-test statistics of the experimental and control groups. The significance of the statistics was tested with Mann Whitney U and Wilcoxon Signed Rank Test.

4.6. Examination of the Relationship Between Attitude Scores of Experimental and Control Group Students

The Mann Whitney U Test was used to statistically analyse the difference between the attitude scale scores of the experimental and control groups in this study. Test results are presented in Table 7.

Table 7.

Mann Whitney U Test results of attitude scale scores according to experimental and control groups

Group	N	Rank Mean	Rank Sum	U	P
Experimental	23	24.41	561.50	243.50	.644
Control	23	22.59	519.50		
Total	46				

*$p > .05$.

Table 7 shows the results of the Mann Whitney U Test of the attitude scale scores according to the experimental and control groups. Accordingly, as a result of the six weeks experimental activities, there was no noticeable difference between the attitude scale post-test scores of the experimental and control groups (p> .05). Based on this finding, it can be said that gamification is not effective in changing students' attitudes towards the mathematics lesson.

4.7. Examination of the Relationship Between Experimental Group Students' Pre-Test and Post-Test Attitude Scale Scores

The Wilcoxon Signed Rank Test was used to statistically analyse the difference between the attitude scale scores of the experimental group. Test results are presented in Table 8.

Table 8.

Wilcoxon Signed Rank Test results of attitude scale scores according to experimental group

Post-Test - Pre-Test	N	Rank Mean	Rank Sum	Z	P
Negative Ranks	9	14.61	131.50	.198	.843*
Positive Ranks	14	10.32	144.50		
Equal	0	-	-		
Total	23				

*$p > .05$.

Table 8 shows the results of the Wilcoxon Signed Rank Test of the attitude scale scores according to the experimental group. Considering the results of the analysis, there is no remarkable difference between the attitude scale scores of the experimental group students before and after the experimental activities (p> .05). According to these results, it can be said that there was no statistically significant change in the experimental group students' attitudes towards the mathematics.

4.8. Examination of the Relationship Between Control Group Students' Pre-Test and Post-Test Attitude Scale Scores

The Wilcoxon Signed Rank Test was used to statistically analyse the difference between the attitude scale scores of the control group. Test results are presented in Table 9.

Table 9.

Wilcoxon Signed Rank Test results of attitude scale scores according to control group

Post-Test - Pre-Test	N	Rank Mean	Rank Sum	Z	P
Negative Ranks	12	11.46	137.50	.357	.721*
Positive Ranks	10	11.55	115.50		
Equal	1	-	-		
Total	23				

*p >.05.

Table 9 shows the Wilcoxon Signed Rank Test results of the control students' attitude scale scores. Considering the analysis results, there is no remarkable difference between the pre-test and post-test attitude scale scores (p>.05). According to these results, it can be said that there was no statistically significant change in the control group students' attitudes towards mathematics course.

5. Discussion, Conclusion and Suggestions

This study aims to determine the effect of gamification on fifth-grade students' academic achievement and attitudes towards the mathematics course. For this purpose, experimental procedures of the current study were carried out in the fifth-grade mathematics course teaching process for six weeks. The research process was conducted with a quasi-experimental design and research data were collected with the academic achievement test and attitude scale. Participants of this research were 46 fifth-grade students. The study results show that gamification positively affects the mathematics achievement of fifth-grade students, but it has no effect on attitude towards mathematics course.

The principal strength of this study is the tangible use of main gamification elements. When the literature is examined, it is seen that digital platforms are mainly used for gamification applications in education (Kim & Castelli, 2021; Klock et al., 2020; Lister, 2015; Manzano-Leon et al., 2021; Swacha, 2021). The current study findings show that gamification can also be beneficial in mathematics education when not conduction with digital tools. In this respect, it is hoped that this study results will contribute to the mathematics education literature.

The experimental applications were performed with two equal classes in terms of academic achievement (U=236.50, p>.05) and attitudes towards the mathematics course (U=216.50, p>.05). Gamification can be defined as briefly, equipping non-game processes with game design elements. Thus, the experimental group's teaching process was equipped with the gamification elements which designed and adapted from Pyramidal Design Model (Werbach & Hunter, 2012) in this study. After the six weeks of the experimental process, the data collection process was completed with post-tests applications.

When the pre-test and post-test scores of the experimental and control groups were compared statistically, the results show that gamification positively affected the students' academic achievement in the mathematics course (U = 143.00, p <.05). In addition, the achievement test pre-test and post-test scores of the experimental and control groups were also compared within themselves and it is seen that the academic achievement of both groups statistically increased. However, it is clearly seen that the increase in the achievement test scores of the experimental group in which the gamification elements were used is significantly higher than the increase in the control group in which the gamification elements were not used. Likewise, the attitude scale scores were compared, and there was no statistically major difference between the scores of the experimental and control groups (U = 243.50, p> .05). Furthermore, the attitude scale pre-test and post-test scores of the experimental and control groups were also compared within themselves, but there is no statistical difference was found (p> .05). In this respect, it is thought that the gamification elements are interesting for students and thus increase their active participation in the course. This situation may have caused this academic achievement differentiation. Thus, this study confirms Ar (2016), Fidan (2016), Yürük (2019), Kumar & Khurana (2012), Cozar-Gutierrez & Saez-Lopez (2016), Yıldırım (2016), Gonzalez et al. (2016), Barata et al. (2013), O'Donovan et al. (2013), Mekler et al. (2013), and Dominguez et al. (2013)'s studies in terms of the positive effects on performance. On the other hand, this study's findings do not support Karatekin (2017), Sağlık (2017), Şahin (2015), Hanus & Fox (2015), De-Marcos et al. (2014), and Haaranen et al. (2014)'s study findings on participant's performance.

On the other hand, considering the attitude scale scores, it can be said that gamification did not have a positive or negative impact on students' attitudes towards the mathematics course. In other words, the gamified teaching process did not create a statistically significant difference in students' perspectives on mathematics course. The findings clearly indicate that the attitude scale pre-test mean scores are 3.97 for the experimental group and 4.19 for the control group. So that the scale is a five-point Likert type, it is seen that the students' attitudes towards the mathematics course were also at a high level before the research process. Hence, it can be seen that the students' attitudes towards the mathematics course are already at a high level. This situation may have caused no statistical difference to be encountered in the analysis of the attitude scale scores. Therefore, this study findings confirm Haaranen et al. (2014), Şahin (2015), Berkling & Thomas (2013), and Mekler et al. (2013)'s studies in terms of observing no significant statistical difference in the participant's attitudes. However, this study differs from Karatekin (2017), Sümer (2017), Fidan (2016), Cozar-Gutierrez & Saez-Lopez (2016), Sağlık (2017), Kingsley & Grabner-Hagen (2015), Gonzalez et al. (2016), Polat (2014), Hamzah et al. (2015), Hanus & Fox (2015), De-Marcos et al. (2014), Abramovich et al. (2013), Yıldırım (2016), Brewer et al. (2013), and Li et al. (2013)'s studies in terms of the participant's attitudes.

There are two major limitations in this study that could be addressed in future research. First, this study is restricted to 46 fifth-grade students at a secondary school located in Turkey's West Black Sea region in the 2018-2019 academic year and the effect of gamification was tested only for mathematics education. Second, since this study was performed with young learners, game elements were concretised as much as possible in order to determine the effect of gamification better. For this reason, digital media tools were not used in this study. It was thought that this condition would provide ease of use of the game elements for young learners. Samples of this situation are included in this study's methodology section. In this respect, some suggestions that may inspire future work are presented below.

- This research is limited to 46 participants. Studies examining the effect of gamification can be conducted with more participants.
- In this research, the effects of gamification on mathematics course were examined. Studies can be conducted to examine the effect of gamification in different courses.
- Participants in this research are limited to the fifth-grade level. Studies that examine the effects of gamification at different grade levels can be conducted.

Acknowledgement

This study was derived from the first author's master thesis titled "*The effect of gamification on the success and attitude of the 5th grade mathematics course*". The second author of this study contributed to the research as the thesis supervisor. The authors' institutions are different and there is no conflict of interest.

References

Abramovich, S., Schunn, C., & Higashi, R. M. (2013). Are badges useful in education?: It depends upon the type of badge and expertise of learner. *Educational Technology Research and Development*, *61*(2), 217-232. https://doi.org/10.1007/s11423-013-9289-2

Ar, N. A. (2016). *The effects of gamification on academic achievement and learning strategies usage of vocational high school students* (Publication No. 423538) [Unpublished master's dissertation, Sakarya University Institute of Educational Sciences]. Turkey CoHE Thesis Center.

Asan, H., & Çeliktürk-Sezgin, Z. (2020). Effects of the educational games on primary school students' speaking skills and speaking anxiety. *Journal of Theoretical Educational Science, 13*(4), 685- 700. https://doi.org/10.30831/akukeg.707517

Avcu, Y. E., & Er, K. E. (2020). Design thinking applications in teaching programming to gifted students. *Journal of Educational Technology & Online Learning, 3*(1), 1-30. https://doi.org/10.31681/jetol.671621

Balakrishnan, V., & Lay, G. C. (2016). Students' learning styles and their effects on the use of social media technology for learning. *Telematics and Informatics, 33*(3), 808-821. https://doi.org/10.1016/j.tele.2015.12.004

Barata, G., Gama, S., Jorge, J., & Gonçalves, D. (2013, October). Improving participation and learning with gamification. In *Proceedings of the First International Conference on Gameful Design, Research, and Applications - Gamification '13* (pp. 10-17). New York, NY: ACM. https://doi.org/10.1145/2583008.2583010

Berkling, K., & Thomas, C. (2013). Gamification of a software engineering course and a detailed analysis of the factors that lead to its failure. Paper presented at the *2013 International Conference on Interactive Collaborative Learning*, 525-530. https://doi.org/10.1109/ICL.2013.6644642

Beyhan, N., & Tural, H. (2007). The effects of using games on student achievement in the teaching of mathematics. *Dokuz Eylül University Buca Faculty of Education Journal*, (21), 37-48. https://dergipark.org.tr/en/pub/deubefd/issue/25430/268316

Bozkurt, A., & Genç-Kumtepe, E. (2014). Oyunlaştırma, oyun felsefesi ve eğitim: Gamification. Paper presented at the *Akademik Bilişim Conference, 5-7* February. http://ab.org.tr/ab14/bildiri/233.pdf

Brewer, R., Anthony, L., Brown, Q., Irwin, G., Nias, J., & Tate, B. (2013). Using gamification to motivate children to complete empirical studies in lab environments. In Proceedings of the *12th International Conference on Interaction Design and Children* (pp. 388-391). ACM. https://doi.org/10.1145/2485760.2485816

Büyüköztürk, Ş., Kılıç-Çakmak, E., Akgün, Ö., Karadeniz, Ş., & Demirel, F. (2018). *Bilimsel Araştırma Yöntemleri* [*Scientific research methods*] (24. Baskı). Pegem.

Cevher, A.Y., & Yıldırım, S. (2020). Investigation of academic studies on learning styles: A systematic review. *HAYEF: Journal of Education, 17*(1); 20-50. https://doi.org/10.5152/hayef.2020.1922

Cozar-Gutierrez, R., & Saez-Lopez, J. M. (2016). Game-based learning and gamification in initial teacher training in the social sciences: An experiment with Minecraftedu. *International Journal of Educational Technology in Higher Education*, *13*(2),1-11. https://doi.org/10.1186/s41239-016-0003-4

De-Marcos, L., Dominguez, A., Saenz-de-Navarrete, J., & Pages, C. (2014). An empirical study comparing gamification and social networking on e-learning. *Computers & Education*, *75*(6), 82-91. https://doi.org/10.1016/j.compedu.2014.01.012

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. https://doi.org/10.1111/jcal.12438

Deterding, S., Dixon, D., Khaled, R., & Nacke, L. (2011). From game design elements to gamefulness: Defining "gamification". *In Proceedings of the 15th International Academic MindTrek Conference: Envisioning future media environments* (pp. 9–15). Tampere, Finland: ACM. https://doi.org/10.1145/2181037.2181040

Dominguez, A., Saenz-de-Navarrete, J., de-Marcos, L., Fernandez-Sanz, L., Pages, C., & Martinez-Herraiz, J. (2013). Gamifying learning experiences: Practical implications and outcomes. *Computers & Education*, *63*, 380-392. https://doi.org/10.1016/j.compedu.2012.12.020

Dursun, Ş., & Dede, Y. (2004). The Factors affecting students' success in mathematics: Mathematics teachers' perspectives. *Gazi University Journal of Gazi Educational Faculty*, *24*(2). http://www.gefad.gazi.edu.tr/tr/pub/issue/6759/90924

Eleyyan, S. (2021). The future of education according to the fourth industrial revolution. *Journal of Educational Technology & Online Learning, 4*(1), 23-30. http://doi.org/10.31681/jetol.737193

Eltem, Ö., & Berber, A. (2020). The use of educational games within the structure and properties of matter unit in science class. *Participatory Educational Research, 8*(2), 200-219. http://dx.doi.org/10.17275/per.21.36.8.2

Fidan, A. (2016). *Effect of gamification in teaching programming with scratch on student engagement* (Publication No. 445164) [Unpublished master's dissertation, Uludağ University Institute of Educational Sciences]. Turkey CoHE Thesis Center.

Fraenkel, J. R., Wallen, N. E., & Hyun, H. H. (2011). *How to design and evaluate research in education* (8th ed). McGraw-Hill.

Garber Jr, L. L., Hyatt, E. M., & Boya, Ü. Ö. (2018). Constituting, testing and validating the gender learner profiles of serious game participants. *The International Journal of Management Education, 16*(2), 205-223. https://doi.org/10.1016/j.ijme.2018.02.005

Gonzalez, C. S., Gomez, N., Navarro, V., Cairos, M., Quirce, C., Toledo, P., & Marrero-Gordillo, N. (2016). Learning healthy lifestyle through active videogames, motorgames and the gamification of educational activities. *Computers in Human Behavior*, *55*, 529-551. https://doi.org/10.1016/j.chb.2015.08.052

Gök, M. (2020). Mathematical mystery in a cultural game. *World Journal of Education*, *10*(6), 64-73. https://doi.org/10.5430/wje.v10n6p64

Gökkaya, Z. (2014). A new approach of adult education: Dramatization. *HAYEF: Journal of Education*, *11-1*(21), 71-84. https://hayefjournal.org/EN/a-new-approach-of-adult-education-dramatization-13478

Gravetter, F. J., Wallnau, L. B., Forzano, L. A. B., & Witnauer, J. E. (2020). *Essentials of statistics for the behavioral sciences* (10th ed.). Cengage Learning.

Haaranen, L., Ihantola, P., Hakulinen, L., & Korhonen, A. (2014). How (not) to introduce badges in online exercises. *SIGCSE '14 Proceedings of the 45th ACM technical symposium on computer science education*, 33-38. https://doi.org/10.1145/2538862.2538921

Hacısalihoğlu-Karadeniz, M. (2017). A general review of acquisitions and problems in the process of adapting and applying traditional children's games into maths. *Kastamonu Education Journal*, *25*(6), 2245-2262. https://dergipark.org.tr/tr/pub/kefdergi/issue/31577/357336

Hamzah, W. M. A. F. W., Ali, N. H., Saman, M. Y. M., Yusoff, M. H., & Yacob, A. (2015). Influence of gamification on students' motivation in using e-learning applications based on the motivational design model. *International Journal of Emerging Technologies in Learning (IJET)*, *10*(2), 30-34. http://dx.doi.org/10.3991/ijet.v10i2.4355

Hanus, M., & Fox, J. (2015). Assessing the effects of gamification in the classroom: A longitudinal study on intrinsic motivation, social comparison, satisfaction, effort, and academic performance. *Computers & Education*, *80*, 152-161. https://doi.org/10.1016/j.compedu.2014.08.019

Karatekin, İ. (2017). *The use of gamification in teaching foreign language vocabulary for beginners* (Publication No. 472341) [Unpublished master's dissertation, Çağ University Institute of Social Sciences]. Turkey CoHE Thesis Center.

Ke, F., & Clark, K. M. (2020). Game-based multimodal representations and mathematical problem solving. *International Journal of Science and Mathematics Education*, *18*(1), 103-122. https://doi.org/10.1007/s10763-018-9938-3

Kim, J., & Castelli, D. M. (2021). Effects of gamification on behavioral change in education: A meta-analysis. *International Journal of Environmental Research and Public Health, 18*(7), 3550. http://dx.doi.org/10.3390/ijerph18073550

Kim, J. T., & Lee, W. H. (2015). Dynamical model for gamification of learning (DMGL). *Multimedia Tools and Applications*, *74*(19), 8483-8493. https://doi.org/10.1007/s11042-013-1612-8

Kingsley, T. L., & Grabner-Hagen, M. M. (2015). Gamification. *Journal of adolescent & adult literacy*, *59*(1), 51-61. https://doi.org/10.1002/jaal.426

Kiryakova, G., Angelova, N., & Yordanova, L. (2014). Gamification in education. Proceedings of *9th International Balkan Education and Science Conference.*

Klock, A. C. T., Gasparini, I., Pimenta, M. S., & Hamari, J. (2020). Tailored gamification: A review of literature. *International Journal of Human-Computer Studies, 144*(102495). https://doi.org/10.1016/j.ijhcs.2020.102495

Kraska-Miller, M. (2013). *Nonparametric statistics for social and behavioral sciences*. CRC Press.

Kumar, B., & Khurana, P. (2012). Gamification in education-learn computer programming with fun. *International Journal of Computers and Distributed Systems*, *2*(1), 46-53.

Lee, J. J., & Hammer, J. (2011). Gamification in education: What, how, why bother? *Academic Exchange Quarterly*, *15*(2), 146.

Li, C., Dong, Z., Untch, R. H., & Chasteen, M. (2013). Engaging computer science students through gamification in an online social network based collaborative learning environment. *International Journal of Information and Education Technology*, *3*(1), 72-77. https://doi.org/10.7763/IJIET.2013.V3.237

Lister, M. (2015). Gamification: The effect on student motivation and performance at the post-secondary level. *Issues and Trends in Educational Technology*, *3*(2). https://doi.org/10.2458/azu_itet_v3i2_Lister

Liu, Z. Y., Shaikh, Z., & Gazizova, F. (2020). Using the concept of game-based learning in education. *International Journal of Emerging Technologies in Learning (IJET), 15*(14), pp. 53-64. http://dx.doi.org/10.3991/ijet.v15i14.14675

Lodico, M. G., Spaulding, D. T., & Voegtle, K. H. (2010). *Methods in educational research: From theory to practice* (Vol. 28). John Wiley & Sons.

Manzano-Leon, A., Camacho-Lazarraga, P., Guerrero, M. A., Guerrero-Puerta, L., Aguilar-Parra, J. M., Trigueros, R., & Alias, A. (2021). Between level up and game over: A systematic literature review of gamification in education. *Sustainability, 13*(2247). https://doi.org/10.3390/su13042247

Mekler, E. D., Brühlmann, F., Opwis, K., & Tuch, A. N. (2013). Do points, levels and leaderboards harm intrinsic motivation?: An empirical analysis of common gamification elements. In *Proceedings of the First International Conference on gameful design, research, and applications*, (pp. 66-73). ACM. https://doi.org/10.1145/2583008.2583017

Milli Eğitim Bakanlığı [Ministry of National Education] [MEB]. (2018). *Matematik dersi öğretim programı (1-8. Sınıflar)* [*Mathematics course curriculum - 1st-8th Grades*]. MEB. http://mufredat.meb.gov.tr/ProgramDetay.aspx?PID=329

Moon, J., & Ke, F. (2020). In-game actions to promote game-based math learning engagement. *Journal of Educational Computing Research, 58*(4), 863-885. https://doi.org/10.1177/0735633119878611

Ndibalema, P. (2020). Unlocking the potential of ICT for transformative learning among youth: A path to 21st century competencies. *Journal of Educational Technology & Online Learning, 3*(3), 245-271. https://doi.org/10.31681/jetol.777647

O'Donovan, S., Gain, J., & Marais, P. (2013). A case study in the gamification of a university-level games development course. In *Proceedings of the South African Institute for Computer Scientists and Information Technologists Conference* (pp. 242-251). ACM. https://doi.org/10.1145/2513456.2513469

Önal, N. (2013). A study on the development of a middle school students' attitudes towards mathematics scale. *Elementary Education Online*, *12*(4), 938-948. http://ilkogretim-online.org.tr/index.php/io/article/view/1360

Pagano, R. R. (2012). *Understanding statistics in the behavioral sciences* (10th ed.). Cengage Learning.

Pett, M. A. (2015). *Nonparametric statistics for health care research: Statistics for small samples and unusual distributions* (2nd ed.). Sage Publications.

Polat, Y. (2014). *A case study: Gamification and its effect on motivation of learners of English* (Publication No. 358356) [Unpublished master's dissertation, Çağ University Institute of Social Sciences]. Turkey CoHE Thesis Center.

Ruiperez-Valiente, J. A., Gaydos, M., Rosenheck, L., Kim, Y. J., & Klopfer, E. (2020). Patterns of engagement in an educational massively multiplayer online game: A multidimensional view. *IEEE Transactions on Learning Technologies, 13*(4), 648-661. http://doi.org/10.1109/TLT.2020.2968234

Sağlık, E. (2017). *The impact of gamified game-based vocabulary teaching on success and motivation* (Publication No. 454559) [Unpublished master's dissertation, Bahçeşehir University Institute of Educational Sciences]. Turkey CoHE Thesis Center.

Salkind, N. J. (2016). *Statistics for people who (think they) hate statistics* (6th ed.). Sage Publications.

Sezgin, S., Bozkurt, A., Yılmaz, E. A., & Van der Linden, N. (2018). Gamification, education and theoretical approaches: Motivation, engagement and sustainability in learning processes. *Mehmet Akif Ersoy University Journal of Education Faculty*, (45), 169-189. https://doi.org/10.21764/maeuefd.339909

Siegel, S. (1956). *Nonparametric statistics for the behavioral sciences*. McGraw-Hill.

Sokal, R. R., & Rohlf, F. J. (2009). *Introduction to biostatistics* (2nd ed.). Dover Publications.

Sümer, M. (2017). *Integrating gamification into open and distance learning* (Publication No. 486284) [Unpublished doctoral dissertation, Anadolu University Institute of Social Sciences]. Turkey CoHE Thesis Center.

Swacha, J. (2021). State of research on gamification in education: A bibliometric survey. *Education Sciences, 11*(2), 69. https://doi.org/10.3390/educsci11020069

Şahin, M. (2015). *The effect of gamified game based learning on students' achievements and attitudes towards science* (Publication No. 414602) [Unpublished master's dissertation, Bahçeşehir University Institute of Educational Sciences]. Turkey CoHE Thesis Center.

Tokac, U., Novak, E., & Thompson, C. G. (2019). Effects of game-based learning on students' mathematics achievement: A meta-analysis. *Journal of Computer Assisted Learning, 35*(3), 407-420. https://doi.org/10.1111/jcal.12347

Turgut, M. F., & Baykul, Y. (2015). *Eğitimde ölçme ve değerlendirme* [*Assessment and evaluation in education*] (7. Baskı). Pegem.

Turgut, Y. (2014). Verilerin kaydedilmesi, analizi, yorumlanması: Nitel ve nicel [Data recording, analysis, interpretation: Qualitative and quantitative]. In A. Tanrıöğen (Ed.), *Bilimsel Araştırma Yöntemleri* [*Scientific research methods*] (4th ed., pp. 193-247). Anı.

Uğurel, I., & Moralı, S. (2008). The interaction of mathematics & game. *Gazi University Journal of Gazi Educational Faculty*, *28*(3), 75-98.

Umay, A. (2002). The other mathematics. *Hacettepe University Journal of Education*, *23*(23), 275-281. https://dergipark.org.tr/tr/pub/hunefd/issue/7815/102648

Werbach, K., & Hunter, D. (2012). *For the win: How game thinking can revolutionize your business*. PA: Wharton Digital Press.

Wood, L. C., & Reiners, T. (2015). Gamification. In M. Khosrow-Pour (Ed.), *Encyclopedia of information science and technology,* (3th ed., pp. 3039-3047). IGI Global. http://doi.org/10.4018/978-1-4666-5888-2.ch297

Yaşar, S. (2018). The role of massively multiplayer online role-playing games in extramural second language learning: A literature review. *Journal of Educational Technology & Online Learning, 1*(3), 1-10. https://doi.org/10.31681/jetol.436100

Yıldırım, İ. (2016). *Development, implementation and evaluation of a gamification based curriculum for the lesson of 'teaching principles and methods'* (Publication No. 422970) [Unpublished doctoral dissertation, Gaziantep University Institute of Educational Sciences]. Turkey CoHE Thesis Center.

Yıldırım, İ., & Demir, S. (2014). Gamification and education. *International Journal of Human Sciences*, *11*(1), 655-670. https://doi.org/10.14687/ijhs.v11i1.2765

Yürük, N. (2019). Edutainment: Using Kahoot! As a review activity in foreign language classrooms. *Journal of Educational Technology & Online Learning, 2*(2), 89-101. https://doi.org/10.31681/jetol.557518