Available online at ijci.wcci-international.org

International Journal of Curriculum and Instruction 18(2) (2026) 133–150

IJCI
International Journal of Curriculum and Instruction

The Impact of Gamification on Students' Attitudes and Achievement in Mathematics Instruction: An Action Research

Dr. Hatice Gözde Uysal [a] [1], Prof. Dr. Mehmet Şahin [b]

[a] *Şehit Savcı Mehmet Selim Kiraz Ortaokulu, Akdeniz, Mersin and 33070, Turkey*
[b] *Mersin University, Yenişehir, Mersin and 33110, Turkey*

Abstract

Within the scope of this paper, which was designed as an action research study, the researcher, who is also a mathematics teacher, investigated the role of gamification in mastery-based mathematics instruction. The study was conducted as an action research, with 25 seventh-grade students attending a public secondary school in the Akdeniz district of Mersin, Turkey. It examined how the implementation affected students' academic achievement, and attitudes. While designing a six-cycle action plan, an instructional program incorporating gamification activities based on mastery learning was prepared. Climate change themes were placed at the center of the instructional program. By utilizing the similarities between the elements of gamification and those of the mastery learning model, these components were integrated with one another. In addition, the study explored how gamification contributed to mastery learning throughout the research. Quantitative data were collected through an academic achievement test, an attitude scale, a retention test, and parallel tests. Quantitative data were analyzed using the non-parametric Wilcoxon Signed-Ranks Test, and qualitative data were analyzed through content analysis. According to the results, there was a significant difference between the students' pre-test and post-test scores in the implementation where mastery-based mathematics instruction was carried out through gamification. Furthermore, the retention test and parallel test results indicated that gamification contributed to mastery learning.

Keywords: Gamification; action research; mathematics; attitude; achievement

1. Introduction

1.1. Introduction to the problem

Continuous changes are occurring in all areas of life worldwide and in Türkiye. In order to keep pace with these changes, it is necessary to accurately identify the problems encountered and their underlying causes, and to develop solutions to them. In this process, benefiting from different scientific disciplines is advantageous. According to Helmenstine (2019) and Işık et al. (2008), mathematics is the common language of these scientific

[1] Corresponding author: Hatice Gözde Uysal. ORCID ID.: https://orcid.org/0000-0002-4594-5329
E-mail address: hgozdeuysal@yahoo.com

disciplines. Therefore, gaining proficiency in this common language can help us solve the problems we encounter and understand the universe. Individuals who understand and can perform mathematics seize important opportunities to shape their futures in this rapidly developing world, and the mathematical competence they possess opens many doors for them (NCTM, 2000). Mathematics enables the explanation of natural phenomena, the production of mathematical models to address them, and provides opportunities for thinking, reasoning, discussion, and inquiry (Altun, 2006). In contemporary education systems, mathematics is accepted not merely as a numerical skill but as a fundamental discipline that develops individuals' logical reasoning and problem-solving abilities (Altun, 2015). However, for many students, mathematics has become a subject associated with fear of failure and negative attitudes due to its abstract nature. International assessment reports (MoNE, 2023a; MoNE, 2023b) reveal that students' levels of mathematical literacy need to be improved and that, in this process, affective characteristics (attitudes, anxiety, motivation) are directly related to academic achievement. At this point, the Mastery Learning Model developed by Bloom (1976) offers an approach focused on equality of opportunity and achievement in education, grounded in the philosophy that "nearly everyone can learn if appropriate learning conditions are provided." Although this statement is not explicitly included in the 2018 and 2024 mathematics curricula, the emphasis on process-oriented assessment, feedback, correction, and reinforcement, as well as the inclusion of elements that take students' individual differences into account, indicates alignment with the components of the mastery learning model (Şahin, 2025).

According to Bloom, 25% of the variance in learning outcomes depends on affective entry characteristics such as attitudes and academic self-confidence, while 50% depends on cognitive entry behaviors. However, during the implementation phase of the model, particularly the "corrective" activities conducted to address the deficiencies of low-achieving students may be perceived by students as a routine and tedious process (Guskey, 2010). In order to overcome this pedagogical barrier, gamification, which is integrated into educational environments, is defined as the use of game elements and mechanics in non-game contexts (Deterding et al., 2011). Kapp (2012) emphasizes that gamification employs game-based mechanics to attract learners' interest, increase motivation, and encourage problem solving. It is known that today's students belong to Generation Z and Generation Alpha, who were born in and after the year 2000 (Crindle, 2022; Kuran, 2020). Therefore, contemporary curricula should be designed to appeal to these two generations. Although students from these generations possess skills such as being active during lessons, benefiting from technology, rapidly establishing connections between topics, and responding to multiple stimuli simultaneously, they experience difficulty in maintaining prolonged attention on a single subject (Altunbay & Bıçak, 2018; Demirel, 2021). These students are individuals who can easily access information through the technological tools at their disposal, are versatile, inquisitive, and able to express their expectations openly (Tozlu, 2021). This situation reveals the necessity of learner-centered, engaging teaching methods that promote active participation and incorporate the use of technology.

According to the Johnson et al. (2013), games and gamification function as simulations of the real world and support students' motivation. Games not only develop cognitive and affective skills but also enhance psychomotor skills, thereby meeting the need for movement (Burgaz Uskan & Bozkuş, 2019). Moreover, important skills acquired through play include decision-making, retention, observation, reasoning, problem-solving, and creative thinking (Özyürek & Çavuş, 2016). The use of games and gamification in education increases students' motivation, develops certain skills, and facilitates the formation of inter-neuronal connections necessary for learning by helping to increase dopamine levels in the nervous system (Çelikyurt et al., 2012). During games, students learn to struggle, win, lose, and cooperate, while simultaneously experiencing both positive and negative emotions such as excitement, fear, empathy, and happiness, thereby developing their affective skills (Özyürek & Çavuş, 2016).

Although gamified learning can be challenging and stressful, when well-designed it provides a safe environment in which learners can acquire the necessary knowledge and skills and facilitates the realization of lasting learning (Velaora et al., 2022). In the gamification process, roles appropriate to each student's level and interests are assigned. In this way, students' active participation in lessons and their engagement in classroom activities can be ensured. In this process, the more attention-grabbing and meaningful the hints and reinforcements provided are, the more they can strengthen students' motivation toward learning and support active participation. In mathematics education, gamification prepares the motivational foundation required for mastery learning by enabling students' active participation in the process through elements such as points, badges, and leaderboards (Hamari & Koivisto., 2014).

1.2. Related studies

Bloom's Mastery Learning model, which is based on the assumption that every student can learn, argues that success rates in schools can increase from 20% to as high as 90% or even 95% (Çavuş & Semerci, 2020). Bloom developed his Mastery Learning Model by building upon Carroll's model and supporting it with the ideas of Morrison, Bruner, Skinner, Suppes, Glaser, Goodlad, and Anderson (Bloom, 1971). This model consists of three components: Student Characteristics, which include students' cognitive and affective entry behaviors; Instruction, which comprises the learning unit(s) and the quality of instructional services; and Learning Outcomes, which may vary according to learning pace, level, and type. This structure is illustrated in the figure below.

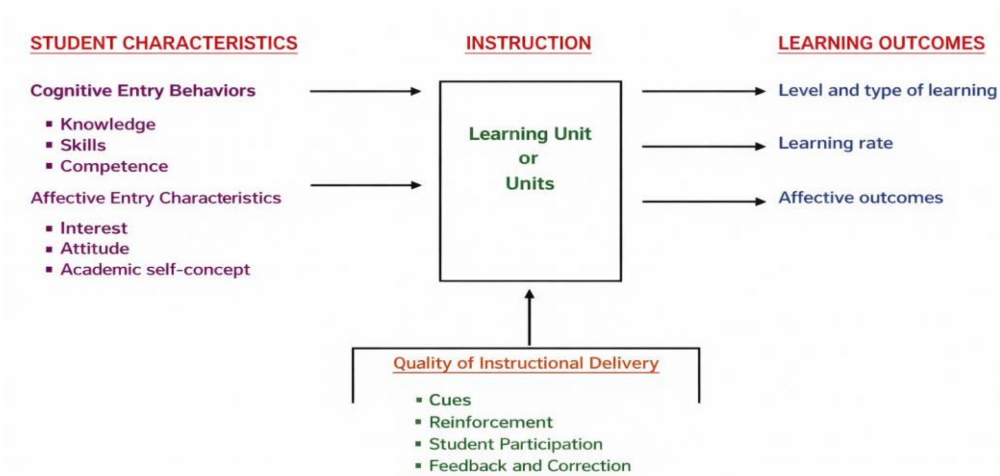

Figure 1. Mastery Learning Model (Bloom, 1979)

A review of the literature indicates that the mastery learning model becomes much more effective when combined with different instructional methods and techniques. Experimental studies have demonstrated that when the mastery learning model is supported by cooperative learning (Jhala, 2003), the flipped classroom model (Lopez & Oquendo, 2024; Özler, 2020), concept maps (Savcı & Kırkıç, 2012), a group-based approach (Ugwu & Nnamani, 2023), and STEM applications (Yıldırım & Selvi, 2017), positive developments in academic achievement and attitudes are observed.

Gamification is defined as the use of game design elements in non-game contexts (Deterding, 2017; Lugmayr et al., 2011). In challenging activities, the reason for recommending gamification is the belief that it increases students' motivation, participation in lessons, and in-class performance. Hunicke et al. (2004) proposed a framework illustrating the principles of gamification, as shown in the figure below. According to this framework, gamification elements consist of three main components: mechanics, dynamics, and aesthetics.

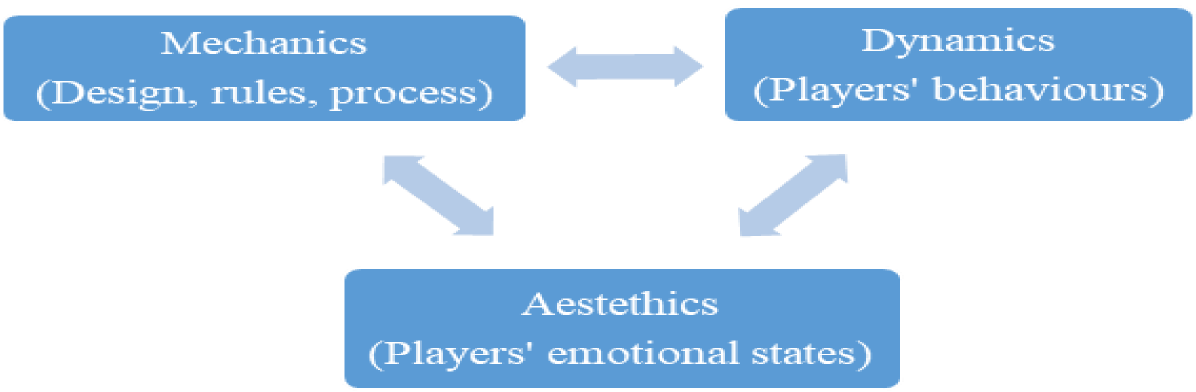

Figure 2. Gamification Principles (Hunicke et al., 2011)

Blanc (2004) argues that although the components of the MDA framework, which constitutes the structure of game design, may appear to be independent, they are in fact interactive elements. He states that mechanics form the fundamental structure and rules of the game, dynamics describe players' interactions with one another and with the elements of the game, and aesthetics represent the emotions experienced by players during gameplay.

It has been stated that when game elements appropriate to students' levels and interests are selected during the design of gamification, gamification increases academic achievement (Bui, 2020; Yıldırım et al., 2019) and has positive effects on attitudes (Çayır, 2021; Dominguez et al., 2013; Gelen & Özer, 2010; Maryana, 2024; Morreira Parrales et al., 2024). Otherwise, factors such as the misalignment of game mechanics with learning objectives and an excessive dependence on extrinsic motivation may increase students' participation or motivation in the course while simultaneously reducing their academic achievement (Dominguez et al., 2013; Hanus & Fox, 2015).

In addition, in the study conducted by Amos (2022), the effects of gamification and mastery learning on academic achievement were compared separately with those of traditional instructional methods. The results showed that both approaches created a statistically significant difference in achievement compared to the traditional method. However, no significant difference was found between the effect sizes of mastery learning and gamification in this study.

A review of the literature reveals only two studies that have employed the mastery learning model in an integrated manner with gamification and examined its effect on academic achievement. In the experimental studies conducted by Pontes et al. (2019) and Reichelt (2015), it was determined that the academic achievement scores of groups in which gamification and mastery learning methods were used together were significantly higher than those of groups taught using traditional methods. In both studies, preventing students from progressing to the next module before reaching a certain level of proficiency increased the permanence and depth of learning in line with the fundamental principles of the mastery learning model. Particularly in Reichelt's study, the inclusion of remedial modules contributed to addressing learning deficiencies and ensuring that all students achieved the targeted learning outcomes.

1.3. Purpose of the study and research questions

The purpose of this study is to examine how gamification-based instructional practices, implemented in accordance with the principles of the mastery learning model, affect students' academic achievement and their attitudes toward the course. In addition, the study aims to contribute both theoretically and practically to teaching practices and the related literature by identifying the factors that enhance the effectiveness of the gamification approach in the instructional process.

In line with this purpose, answers were sought to the following research questions:

1. How did the mathematics achievement pre-test and post-test scores of students who participated in mastery learning–based gamification activities change?
2. How did the mathematics attitude pre-test and post-test scores of students who participated in mastery learning–based gamification activities change?

2. Method

The method of this study was designed as action research, which is also referred to as teacher research when implemented in educational settings (Köklü, 2021), and is used to solve a problem encountered by the teacher as a result of observations made during practice (Büyüköztürk et al., 2020). Considering Mills's (2014) types of action research, this study is classified as practical action research, as it focuses on the process in order to address the problems experienced by the researcher in the classroom and to produce solutions to them. In terms of its model, it is consistent with operational action research, as it follows a cyclical process that includes the stages of planning, acting, observing, and reflecting.

This action research was conducted during the 2024–2025 academic year in 7th-grade students' mathematics applications course and focused on the topics of ratio–proportion and percentages. Prior to the implementation of the action plan, a gamification-supported, mastery learning–based mathematics instructional plan was developed with climate crisis issues placed at the center. For this purpose, relevant learning outcomes were selected from the 7th-grade curricula of mathematics, social studies, science, and environmental and climate change education. Taking into account the similarities between the mastery learning model and gamification, a lesson plan was designed based on the MDA gamification model (Hunicke et al., 2011) in line with Marczewski's (2016) Gamification Framework. In addition, the six-step gamification design model developed by Werbach and Hunter (2012) was incorporated into the plan.

The plan was subsequently reviewed by an expert in gamification, and the necessary revisions were made. By mutual agreement, it was decided that modifications could be made to the lesson plan during the process. Heterogeneous student groups were formed in a balanced manner according to Bartle's (1996) player types.

Figure 3. Activities Conducted Prior to the Implementation of the Action

2.1. *Participant characteristics*

The researcher observed that among the students whom she had been teaching for three years and who were in the 7th grade during the 2023–2024 academic year, the students who actively participated in mathematics lessons were consistently the same individuals, which increased the disparity in academic achievement within the classroom. Therefore, in order to address this situation, Class 7/C—characterized by the highest academic achievement range and the lowest number of students with absenteeism—was selected. In selecting the participants, criterion sampling, one of the purposive sampling methods, was employed. In criterion sampling, the characteristics of the group to be studied are determined in advance, and in-depth research is conducted with this group for a specific purpose (Büyüköztürk et al., 2020). The criteria used in this study were the highest difference in students' achievement levels (range) and the lowest level of absenteeism. The distribution of the students in the study group by gender is presented in the table below.

Table 1. Distribution of the number of the students participating in the study by gender

Gender	Number of the students
Female	11
Male	14
Total	25

As shown in the table, the study group consisted of a total of 25 students, including 11 female and 14 male students

2.1. Implementation of the action plan

Based on the information obtained at the end of the literature review, the researcher determined the research problem and research questions. In the subsequent stage, among the four classes she taught, she selected the 7th-grade students who were most suitable for the purpose of the study. She then decided on the instructional method to be used in mathematics teaching and prepared lesson plans accordingly. The research method was determined as action research. Subsequently, the data collection instruments were identified, and the achievement test was administered to 8th-grade students in a different school, while the attitude scale was administered to 7th-grade students. Validity and reliability studies were then conducted. During the spring semester of the 2024–2025 academic year, an action plan consisting of six cycles was implemented. The action plans were applied to the topics of ratio–proportion and percentages in mathematics lessons. The action plan was concluded when mastery learning was determined to have been achieved.

2.1.1. Action plan 1

In the first action plan, students were informed about the study to be conducted. Pre-measurements were evaluated using the Mathematics Achievement Test (OOYT) and the Mathematics Attitude Scale (MYTÖ). These measurements aimed to identify students' prior cognitive characteristics in accordance with the principles of the mastery learning model. As a result of these measurements, deficiencies in students' prior learning were identified. Consequently, the topic in which prior deficiencies were detected was included in the subsequent action plan. Thus, in accordance with the mastery learning model, the number of previously planned modules was increased from two to three. Student groups were formed based on player types, a classroom seating arrangement was organized according to the groups, and desks were arranged accordingly. Group leaders were selected.

2.1.2. Action plan 2

The plan titled "The Beginning of the Energy Adventure" was implemented including two lessons.

In the first lesson; in order to prepare students for the topic and for the lessons to be conducted through mastery learning–based gamification, this cycle aimed to provide students with information about climate crisis issues. Activities were organized within this context. First, the video TEMA–Climate Change 2, prepared by TEMA Vakfı [TEMA foundation] for middle school students, was shown. It was stated that new groups would be determined based on the responses obtained from this activity. While group leaders remained the same as determined in the previous cycle, their opinions were also taken into account during the formation of groups. Player types were distributed equally among the groups during grouping. Based on the responses received, the levels of the student groups were equalized. Subsequently, information about greenhouse gases was provided, emphasizing that they are a factor causing the climate crisis, and students were introduced to the Climate Crisis Terminology Cards (Appendix 5). The cards were then distributed so that each student received one card. Using the jigsaw technique, it was aimed for students to learn all the terms written on the cards. Immediately after the jigsaw activity, a taboo game related to the climate crisis, prepared by İklim TEMA Vakfı [Climate TEMA Foundation] (2024), was played to check students' knowledge. All members of the group that gave the highest number of correct answers were awarded a Climate Professor badge.

In the second lesson; deficiencies in prior cognitive learning identified through the Mathematics Achievement Test (OOYT) were determined to be related to the topic of ratio. For this reason, the topic of ratio, which is actually a 6th-grade topic, was reviewed in this lesson. It was decided to add a leaderboard, one of the gamification elements, in the following week, as students expressed a desire to see the points they received at the end of each section and to learn their group's ranking. It was also decided to incorporate reinforcements into the process. A ratio monitoring test was administered.

2.1.3. Action plan 3

In the third action plan, the plan titled "Character Introduction: Green Heroes" was implemented including two lessons.

In the first lesson of the third action plan, a video describing Gilindire Cave was shown. After the video, students were given a worksheet that included ratio questions to be answered based on the data presented in the video, and they were asked to respond collaboratively as a group. While observing the students answering the questions, the researcher noticed that not all students were actively participating. For this reason, the researcher took the initiative to incorporate a game called Bottle Snatching into the process. In this game, one student from each group was selected to answer the questions posed by the researcher. The student who gave the correct answer in the shortest time earned points for their group and also gained the right to transfer one student from another group to their own group. In this way, all students were actively involved in the process. In the second half of the first lesson, the researcher told a story in which the students themselves were also heroes and described the characters and missions of the heroes in the story. Subsequently, in order to help students better visualize the story and its setting, the researcher posed several guiding questions. The lesson was concluded with the administration of a Ratio Monitoring Test.

Students were given cards labeled with the name of one type of sustainable energy in the second lesson of this plan. Thus, each group became responsible for a specific energy type. It was emphasized that each of these energy types represented a type of green hero. Students were asked to use their imagination to create profile cards for their assigned energy type and to design a logo with a unique slogan for their group. They were informed that they could use the interactive whiteboard while completing this task. Throughout the lesson, students developed their drafts. Subsequently, expert cards containing assigned tasks were distributed. Students were asked to complete these tasks at home and to present their work to the whole class in the following lesson.

2.1.4. Action plan 4

The plan titled “Energy Collection Mission” was implemented. The first lesson began with student research presentations. Groups that completed all questions accurately in their presentations received full points. The results of the Ratio Monitoring Test were evaluated, and it was determined that the desired level had been achieved. Therefore, the action plan proceeded to the topic of ratio–proportion, corresponding to the second module of the mastery learning model. The topic of ratio–proportion was taught using EBA (Educational Informatics Network) content.

The description of manipulations or interventions should include several elements. Carefully describe the content of the intervention or specific experimental manipulations. Often, this will involve presenting a brief summary of instructions given to participants. If the instructions are unusual or compose the experimental manipulation, you may present them verbatim in an appendix or in an online supplemental archive. If the text is brief, you may present it in the body of the paper if it does not interfere with the readability of the report.

In the second lesson, real-life problems prepared by the researcher in accordance with the gamification scenario were solved. The problems are presented below:

- In Gilindire Cave, trees can grow on the level above the lake. There are saplings waiting to be planted, each measuring 50 cm. When planted, these saplings will grow 50 cm each year. When they reach 5.5 meters, they will become mature trees and will be able to absorb 50 kg of carbon dioxide annually. Over the past five years, the amount of carbon dioxide has increased by 0.2 tons, while the lake in the cave has absorbed enough carbon dioxide to reduce this increase by half. This situation has increased the acidity of the lake and endangered aquatic life. If trees are not planted in the cave, this increase will continue to rise proportionally by 0.2 tons every five years. Your task is to protect aquatic life and the ecosystem by preventing the increase in carbon dioxide and stopping the lake's carbon dioxide absorption.

- How can you achieve this?
- In how many years at minimum can you achieve this?
- How many trees do you need for this purpose?

Points were awarded for correct answers. The group with the highest score received the Environmental Protector badge (Appendix 6). At the end of the lesson, the Ratio and Proportion Monitoring Test was administered.

2.1.5. Action plan 5

The topic of percentages was taught using EBA content, and example problems were solved in the first lesson.

In the second lesson of the fifth action plan, the following real-life problem was solved in accordance with the gamification scenario:

- In Gilindire Cave, trees can grow on the level above the lake. There are saplings waiting to be planted, each measuring 50 cm. When planted, these saplings will grow 50 cm each year. When they reach 5.5 meters, they will become mature trees and will be able to absorb 50 kg of carbon dioxide annually. Over the past five years, the amount of carbon dioxide has increased by 0.2 tons, while the lake has absorbed enough carbon dioxide to reduce this increase by half. This situation has increased the acidity of the lake and endangered aquatic life. If trees are not planted in the cave, this increase will continue to rise proportionally by 0.2 tons every five years. Your task is to protect aquatic life and the ecosystem by preventing the increase in carbon dioxide and stopping the lake's carbon dioxide absorption.
- If there were a carbon dioxide elimination device, that is, a superpower, somewhere nearby that eliminated 10% of carbon dioxide each year, how would your answers to the questions asked in the third week change?
- In how many years at minimum could you achieve this?
- How many trees would you need for this purpose?
- How long would it take if no trees were used?

At the end of the lesson, the Percentages Monitoring Test was administered.

2.1.6. Action plan 6

In the sixth action plan, the plan titled "Change the Groups" was implemented. Students were divided into level-based groups: Group 1 (advanced level), Group 2 (upper-intermediate level), Group 3 (lower-intermediate level), and Groups 4 and 5 (basic level). Activities appropriate to each group's level and learning deficiencies were planned. For the first two groups, activities aimed at developing problem-posing skills were designed. For the last two groups, a Percentages Worksheet was prepared, while for the third group, an activity requiring students to match questions with their corresponding answers was designed.

For the first two groups, three word cards and one percentage card were distributed to each group. The content written on the cards differed between the two groups. Students were first asked to individually write and solve a problem using these cards, and then to collaboratively write and solve a single problem as a group. Subsequently, the third group was given four question cards and four answer cards and asked to correctly match the questions with the answers. The final two groups were given the Percentages Worksheet. During the activity, each group was supported, and guidance was provided where students experienced difficulty. This activity continued for two class periods. At the end of the second lesson, the Percentages Parallel Test was administered.

2.1.7. Final week

As the results of the Percentages Parallel Test indicated that students had reached the desired level, the implementation was concluded. Volunteer students were asked to summarize the entire process. Based on the data obtained from the tests administered at the end of the modules, it was determined that mastery learning had been achieved and that the desired learning level had been reached. For this reason, all students were awarded the Organic Brain badge. Interviews were conducted with students selected for the focus group, and their opinions regarding the implementation were obtained. Finally, the post-tests of the Mathematics Achievement Test (OOYT) and the Mathematics Attitude Scale (MYTÖ) were administered.

2.2. Data collection

In this study, the Ratio–Proportion and Percentages Achievement Test (OOYT), developed by the researcher, was used as the data collection instrument. The test was administered to students as a pre-test and post-test before and after the implementation in order to measure students' academic achievement in the topics of ratio–proportion and percentages. In cases where test items have clearly defined correct and incorrect answers, such as multiple-choice tests, reliability can be calculated using KR-20; when item difficulties are similar, KR-21 can be used (Akyıldız, 2008). For this reason, both KR-20 and KR-21 were used to calculate the reliability of the OOYT. The KR-20 value was calculated as 0.91 and the KR-21 value as 0.90, indicating that the test has high reliability. It was decided that four items with an item difficulty index of $r < 0.30$ should be removed from the test.

To measure students' attitudes toward mathematics, the Mathematics Attitude Scale (MYTÖ) developed by Önal (2013) was used. This scale was designed by Önal (2013) as a five-point Likert-type scale consisting of 22 items and four factors: interest, anxiety, necessity, and study. The internal consistency coefficients (Cronbach's alpha) of the factors were reported as 0.89 for Interest (10 items), 0.74 for Anxiety (5 items), 0.69 for Study (4 items), and 0.70 for Necessity (3 items). The overall internal consistency coefficient (Cronbach's alpha) of the scale was found to be 0.90.

2.3. Data analysis

In the study, students' academic achievement was measured using the Ratio–Proportion and Percentages Achievement Test (OOYT) developed by the researcher. To measure changes in students' attitude scores, the Mathematics Attitude Scale (MYTÖ) developed by Önal (2013) was used. Pre-test and post-test administrations were conducted for both instruments.

When the sample size exceeds 30, even if the normality of the population distribution is unknown, the sample distribution is assumed to approximate normality and parametric tests can be used (Ovla et al., 2017). The number of groups to be compared is also an important consideration. In this study, since the number of participants was fewer than 30 (n < 30) and measurements were taken twice at different time points, the Wilcoxon Signed-Rank Test, a non-parametric test, was used to determine whether there was a statistically significant difference between pre-test and post-test scores (Büyüköztürk, 2020).

3. Results

3.1. Results related to the first research question

The results of the Wilcoxon Signed-Rank Test examining whether there was a significant difference between students' academic achievement before and after the implementation are presented in Table 2.

Table 2. Wilcoxon signed-rank test results for OOYT pre-test and post-test scores

Post-test&Pre-test	N	Mean rank	Sum of ranks	Z	p
Negative ranks	3	10.17	30.50	-3.422	.001
Positive ranks	21	12.83	269.50		
Ties	1				
Total	5				

Note. $^{*}p < .05$.

The analysis results indicate a statistically significant difference between students' academic achievement scores before and after the implementation (z = -3.422, p < .05). Considering the mean ranks and sum of ranks of the difference scores, the observed difference favors the positive ranks, that is, the post-test. Accordingly, it can be stated that the gamification-supported mastery learning model implemented in this study had a significant effect on improving students' mathematics achievement.

3.2. Results related to the second research question

The results of the Wilcoxon Signed-Rank Test examining whether there was a significant difference between students' attitudes before and after the implementation are presented in Table 3.

Table 3. Wilcoxon signed-rank test results for MYTÖ pre-test and post-test scores

Post-test&Pre-test	N	Mean rank	Sum of ranks	Z	p

Negative ranks	0	.00	.00	-4.202	.000
Positive ranks	23	12	276		
Ties	2				
Total	25				

Note. *p < .05.

The analysis results indicate a statistically significant difference between students' attitude scores before and after the implementation ($z = -4.202$, $p < .05$). Intervention or manipulation fidelity

4. Discussion and conclusion

According to the research findings, students who participated in mastery learning–based gamification activities achieved significantly higher post-test scores in mathematics achievement compared to their pre-test scores. This result indicates that integrating gamification with the mastery learning model is an effective approach for increasing students' academic achievement. During the implementation process, it was observed that students were more actively involved in the learning process not only cognitively but also affectively, and that game mechanics such as task completion, earning badges, accumulating points, and progressing through levels supported motivation for learning.

This finding is consistent with similar studies reported in the literature. Experimental studies conducted by Pontes et al. (2019) and Reichelt (2015) found that groups in which gamification and mastery learning methods were used together achieved significantly higher academic achievement scores than groups taught using traditional methods. In both studies, preventing students from progressing to the next module before reaching a certain level of proficiency increased the permanence and depth of learning in accordance with the fundamental principles of the mastery learning model. Particularly in Reichelt's study, remedial modules contributed to addressing learning deficiencies and ensuring that all students achieved the targeted learning outcomes.

Similarly, meta-analyses quantitatively examining the effect of gamification on academic achievement support the results of this study. In an analysis of 45 experimental studies conducted by Yıldırım et al. (2019), gamification was found to have a moderate effect size on academic achievement (ES = 0.557). Bai (2020) likewise reported a moderate effect size (ES = 0.507) in a meta-analysis of 24 studies. These results indicate that gamification supports students' academic performance by simultaneously activating affective and cognitive factors in the learning process. Experimental studies conducted using the mastery learning model also align with these findings. Yıldırım and Selvi (2017) reported that mastery learning components played a decisive role in students' achievement gains when combined with STEM-based instruction in science education. Jhala (2003), Savcı and Kırkıç (2012), and Ugwu and Nnamani (2023) similarly reported significant increases in students' achievement levels when mastery learning was supported by cooperative learning, concept maps, and group-based approaches in different subjects and grade levels. These findings demonstrate that the effectiveness of mastery learning is strengthened when integrated with different instructional methods.

Studies by Lopez and Oquendo (2024) and Özler (2020) further showed that supporting mastery learning with different technological or pedagogical models (e.g., the flipped classroom model) reinforced academic achievement gains, highlighting the structural flexibility of the mastery learning approach and its ability to work synergistically with diverse instructional strategies.

Despite the large number of studies emphasizing the positive effects of gamification on academic achievement, the literature also includes studies reporting different outcomes. Dominguez et al. (2013) and Hanus and Fox (2015) found that although students' participation levels increased in gamified courses, their academic achievement decreased. These contradictory findings are attributed to factors such as the misalignment of game mechanics with learning objectives, excessive reliance on extrinsic motivation, and imbalances in instructional design. In this regard, it can be argued that the effectiveness of gamification depends not merely on whether it is used, but on how it is implemented, how well it aligns with students' profiles, and the quality of feedback processes.

On the other hand, Amo and Aou (2022) reported that both gamification and mastery learning methods produced significant achievement differences compared to traditional instruction, but no significant difference was found between their effect sizes. This result suggests that both approaches are powerful and effective in enhancing achievement, and that their effect sizes may be similar.

The results of the study also revealed that students who participated in mastery learning–based gamification activities showed a statistically significant increase in their post-test attitude scores toward mathematics compared to their pre-test scores. This finding indicates that combining gamification with the mastery learning approach can positively influence students' attitudes toward the course. Active participation in the learning process, experiencing a sense of achievement, having opportunities for individual progress, and enjoying learning environments supported by game elements contributed to the development of positive emotions toward the course.

Although no studies were found in the literature that directly examined the effect of combining mastery learning and gamification on attitudes, numerous studies have demonstrated that both approaches individually have positive effects on attitudes. In particular, studies integrating mastery learning with different instructional approaches have reported increases in students' interest and positive attitudes toward the course (Jhala, 2003; Oquendo & Lopez, 2024; Savcı & Kırkıç, 2012; Özler, 2020; Ugwu & Nnamani, 2023; Yıldırım & Selvi, 2017).

Jhala (2003) found that the attitude scores of the experimental group in which cooperative learning and mastery learning were implemented together were significantly higher than those of the control group. Similarly, Yıldırım and Selvi (2017) reported that STEM-based mastery learning applications in science education produced the most pronounced increase in students' attitudes. These findings indicate that mastery learning's emphasis on individual differences, remediation of learning deficiencies, and continuity in the learning process has a direct positive effect on attitudes.

Hayat (2018), who quantitatively examined the effect of mastery learning on attitudes, reported in a meta-analysis involving 4th–8th grade students that mastery learning had a strong effect, particularly in mathematics courses (ES = 0.601), with an overall large effect size of 0.609. Similarly, Batdı (2016) found a large effect size (ES = 0.904) for mastery learning's impact on attitudes in a meta-analysis of experimental studies conducted between 2013 and 2014. These results support the conclusion that mastery learning produces positive affective outcomes and strengthens students' motivation and confidence toward learning.

The role of gamification in improving students' attitudes toward the course is also frequently emphasized in the literature. Çayır (2021) and Gelen and Özer (2010) observed significant increases in students' attitude scores in gamified mathematics instruction, although they reported the effect to be at a moderate level. Maryana et al. (2024) similarly reported that gamification significantly improved middle school students' attitudes toward mathematics. In contrast, a study conducted by Moreira Parrales et al. (2024) found that gamification had a neutral effect on attitudes. This variation suggests that the outcomes of gamification designs may differ depending on variables such as students' age level, interests, and sensitivity to reward systems.

Acknowledgement:

This article is based on the doctorate dissertation titled "The role of gamification in mastery-based mathematics instruction: An action research", which was written by the first author under the supervision of the second author.

References

Altun, M. (2006). Matematik öğretiminde gelişmeler [Developments in mathematics education]. *Eğitim Fakültesi Dergisi, 2*, 223–238.

Altun, M. (2015). *Matematik öğretimi* (11th ed.). Alfa Aktüel Yayınları.

Altunbay, M., & Bıçak, N. (2018). Türk eğitimi derslerinde Z kuşağı bireylerine uygun teknoloji tabanlı uygulamaların kullanımı [The use of technology-based applications suitable for Generation Z individuals in Turkish education courses]. *Journal of World of Turks, 10*(1), 127–142.

Amos, O. O. (2022). Effects of gamification and mastery learning strategies on students' performance and retention in mathematics in Oju Local Government Area of Benue State. *British Journal of Education, 10*(8), 18–30.

Bartle, R. (1996). Hearts, clubs, diamonds, spades: Players who suit MUDs. *Journal of MUD Research, 1*(1), 19. Retrieved from https://www.hayseed.net/MOO/JOVE/bartle.html

Bloom, B. S. (1971). Mastery learning. In J. H. Block (Ed.), *Mastery learning: Theory and practice* (pp. 47–63). Holt, Rinehart and Winston.

Bloom, B. S. (1976). *Human characteristics and school learning*. McGraw-Hill.

Bui, A., Veit, D., & Webster, J. (2015). Gamification: A novel phenomenon or a new wrapping for existing concepts? In *Proceedings of the 36th International Conference on Information Systems (ICIS 2015)* (pp. 1–21).

Burgaz Uskan, S., & Bozkuş, T. (2019). Eğitimde oyunun yeri [The place of play in education]. *International Journal of Contemporary Educational Studies, 5*(Special Issue), 123–131. Retrieved from https://dergipark.org.tr/tr/pub/intjces/issue/51237/667992

Büyüköztürk, Ş. (2020). *Sosyal bilimler için veri analizi el kitabı* (27th ed.). Pegem Akademi. doi:10.14527/9789756802748

Crindle, M. (2022). *Generation Alpha*. McCrindle. Retrieved from https://mccrindle.com.au/articles/

Çayır, M., & Can, F. (2021). Oyunlaştırma yaklaşımının 3. sınıf okuma ve yazılı anlatım becerilerine yönelik tutuma ve akademik başarıya etkisi. *BUGU Dil ve Eğitim Dergisi, 2*(3), 343–365. doi:10.46321/bugu.65

Demirel, Z. H. (2021). Çalışma hayatında geleceğin insan kaynağı: Alfa kuşağı. *OPUS Uluslararası Toplum Araştırmaları Dergisi, 18*(Management and Organization Special Issue), 1798–1827. doi:10.26466/opus.895924

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). ACM. doi:10.1145/2181037.2181040

Deterding, S. (2017). The Pyrrhic victory of game studies. *Games and Culture, 12*(6), 521–543. doi:10.1177/1555412016665067

Domínguez, A., Saenz-de-Navarrete, J., de-Marcos, L., Fernández-Sanz, L., Pagés, C., & Martínez-Herráiz, J. J. (2013). Gamifying learning experiences. *Computers & Education, 63*, 380–392. doi:10.1016/j.compedu.2012.12.020

Gelen, İ., & Özer, B. (2010). Oyunlaştırmanın beşinci sınıf matematik dersinde problem çözme becerisi ve derse karşı tutum üzerindeki etkisi. *Education Sciences, 5*(1), 71–88.

Guskey, T. R. (2010). Lessons of mastery learning. *Educational Leadership, 68*(2), 52–57.

Hanus, M. D., & Fox, J. (2015). Assessing the effects of gamification in the classroom. *Computers & Education, 80*, 152–161. doi:10.1016/j.compedu.2014.08.019

Hamari, J., & Koivisto, J. (2014). Measuring flow in gamification. *Computers in Human Behavior, 40*, 133–143. doi:10.1016/j.chb.2014.07.018

Helmenstine, A. M. (2019). Why mathematics is a language. Retrieved from https://www.scribd.com/document/567756708/3-Why-Mathematics-Is-a-Language

Hunicke, R., LeBlanc, M., & Zubek, R. (2004). MDA: A formal approach to game design and game research. In *Proceedings of the AAAI Workshop on Challenges in Game AI* (pp. 1–5).

Işık, A., Çiltaş, A., & Bekdemir, M. (2008). Matematiğin gerekliliği ve önemi. *Atatürk Üniversitesi Kazım Karabekir Eğitim Fakültesi Dergisi, 17*, 174–184. Retrieved from https://dergipark.org.tr/en/download/article-file/31367

İklim TEMA Vakfı. (2024, January 30). Tabu oyunu: Climate change taboo game (Middle school activity). Retrieved from https://iklimtema.org/?/ortaokul/etkinlik/iklim-degisikligi-tabu-oyunu

Jhala, B. A. (2003). *A study of the effectiveness of cooperative learning and mastery learning approaches in teaching algebra in standard IX A* (Master's thesis). Sardar Patel University.

Johnson, L., Adams Becker, S., Cummins, M., Estrada, V., Freeman, A., & Ludgate, H. (2013). *NMC Horizon Report: 2013 K–12 edition*. The New Media Consortium. Retrieved from https://files.eric.ed.gov/fulltext/ED559366.pdf

Kapp, K. M. (2012). *The gamification of learning and instruction: Game-based methods and strategies for training and education*. John Wiley & Sons.

Köklü, N. (2001). Eğitim eylem araştırması: Öğretmen araştırması. *Ankara Üniversitesi Eğitim Bilimleri Fakültesi Dergisi, 34*(1), 35–43. doi:10.1501/Egifak_0000000040

Kuran, E. (2020). *Z kuşağını anlamak* (7th ed.). Mundi Kitap.

Marczewski, A. (2016). *Game-based solution design*. Gamified UK. Retrieved from https://www.gamified.uk/gamification-framework

Maryana, M., Halim, C., & Rahmi, H. (2024). The impact of gamification on student engagement and learning outcomes in mathematics education. *International Journal of Business, Law, and Education, 5*(2), 1697–1608. doi:10.56442/ijble.v5i2.682

Mills, G. E. (2003). *Action research: A guide for the teacher researcher* (5th ed.). Pearson.

Ministry of National Education. (2023a). *PISA 2022: Türkiye raporu*. Retrieved from https://pisa.meb.gov.tr/meb_iys_dosyalar/2023_12/05125555_pisa2022_rapor_051223.pdf

Ministry of National Education. (2023b). *TIMSS 2023: Türkiye raporu*. Retrieved from https://www.meb.gov.tr/meb_iys_dosyalar/2020_12/10173505_No15_TIMSS_2019_Turkiye_On_Raporu_Guncel.pdf

Moreira Parrales, M. L., Mejía Carrillo, M. de J., Suarez Ibujes, M. O., & Torres Penafiel, J. S. (2024). Gamification for learning mathematics in secondary school: Most effective gamified strategies to motivate students and improve their performance in mathematics. *Salud, Ciencia y Tecnología, 4*, 1016. doi:10.56294/saludcyt20241016

National Council of Teachers of Mathematics. (2000). *Principles and standards for school mathematics*. Author.

Oquendo, J. Z., & Lopez, M. J. D. (2024). Mastery learning strategy on general mathematics performance of Grade 11 STEM students: A pretest–posttest control group study. *Industry and Academic Research Review, 5*(1). doi:10.53378/iarr.924.122

Özler, A. (2020). *Oyunlaştırma yaklaşımının 3. sınıf okuma ve yazılı anlatım becerilerine yönelik tutuma ve akademik başarıya etkisi* (Doctoral dissertation). Adnan Menderes University.

Pontes, A. de, Silva, E. da, & Oliveira, F. de. (2019). Analyzing gamification impact on a mastery learning introductory programming course. *International Journal of Computer Science Education Research, 7*(2), 12–24.

Reichelt, A. L. (2015). *Effects of gamification: Analyzing student achievement, mastery, and motivation in science classrooms* (Doctoral dissertation). Montana State University. Retrieved from https://scholarworks.montana.edu/handle/1/10160

Savcı, H., & Kırkıç, K. A. (2012). Tam öğrenme yönteminin kavram haritalarıyla birlikte kullanıldığında kimya öğrencilerinin başarı düzeylerine etkisi. *İstanbul Sabahattin Zaim Üniversitesi Sosyal Bilimler Dergisi, 1*, 194–226.

Şahin, M. (2025). Comparative analysis of 2015, 2018, and 2024 primary school mathematics curricula. *Ondokuz Mayıs Üniversitesi Eğitim Fakültesi Dergisi, 44*(1), 71–144. doi:10.7822/omuefd.1594613

Tozlu, N. (2021). Öğrenci ve öğretmen yetiştirme sürecinde kuşak sorunu ve kalite/gelişim üzerine inceleme. *Bayburt Eğitim Fakültesi Dergisi, 17*, 720–735. doi:10.35675/befdergi.841261

TEMA Vakfı. (2024, January 30). İklim değişikliği 2 [Video file]. Retrieved from https://www.youtube.com/watch?v=F4i4ca84xis

Ugwu, C. B. A., & Nnamani, D. C. (2023). Effect of group-based mastery learning model on academic achievement of students in basic science. *Sapientia Foundation Journal of Education, Sciences and Gender Studies, 5*(1), 135–143.

Velaora, C., Dimos, I., Tsagiopoulou, S., & Kakarountas, A. (2022). A game-based learning approach in digital design course to enhance students' competency. *Information, 13*(4), 1–26. doi:10.3390/info13040177

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

Yıldırım, B., & Selvi, M. (2017). STEM uygulamaları ve tam öğrenmenin etkileri üzerine deneysel bir çalışma. *Eğitimde Kuram ve Uygulama, 13*(2), 183–210. doi:10.17244/eku.310143

Yıldırım, İ., & Şen, S. (2019). The effects of gamification on students' academic achievement: A meta-analysis study. *Interactive Learning Environments, 29*(8), 1301–1318. doi:10.1080/10494820.2019.1636089