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Research Article

Transforming mathematics education through gamification: A study on motivation and learning among UAE sixth graders

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ABSTRACT

The purpose of this study was to explore the impact of gamification on sixth-grade mathematics performance and motivation in the United Arab Emirates, addressing PISA-identified challenges amid the COVID-19 pandemic. Using a quasi-experimental design, 94 students participated in the study, and three assessment tools (pre-test, post-test, and questionnaire) were employed. The research compares traditional teaching methods with gamification, revealing a substantial performance difference (experimental group mean = 13.5, control group mean = 8.8), which highlights the effectiveness of gamification. Additionally, students conveyed positive perspectives on increased motivation, concentration, and engagement. The findings provide valuable insights into the potential of gamification across diverse educational settings, with significant implications for educators, curriculum designers, and researchers. This research underscores the relevance of incorporating gamification strategies to address contemporary challenges in mathematics education.

Keywords: mathematics education, gamification, motivation enhancement, PISA

INTRODUCTION

The growth of technology has had a significant and positive effect on education. A notable example is ‘gamification,’ an increasingly ubiquitous learning approach that developed with the expansion of digital learning technologies. Since 2010, the term ‘gamification’ has encapsulated a societal phenomenon affecting technologically educated individuals (Simões et al., 2013). Gamification has been given several definitions, each nest within specific contexts. Surendeleg and Murwa (2014) describe it as an ‘educational strategy’ used to increase student motivation and enthusiasm, thereby improving readiness for learning. Many studies have evaluated the effectiveness of gamification in improving motivation and learning (Budasi et al., 2020; Hong & Masood, 2014; Park & Kim, 2021).

Systematic reviews and meta-analyses across K-12 and higher education report generally positive but heterogeneous effects on motivation, engagement, and, in some cases, learning, with outcomes strongly dependent on context and design quality (Seaborn & Fels, 2014). Similarly, Sailer and Homner (2019) found that while gamification yields small but significant improvements in cognitive, motivational, and behavioral learning outcomes, its effectiveness is highly influenced by methodological rigor and contextual factors. They also highlight challenges such as unstable effects on motivation and behavior, and unresolved variables affecting cognitive outcomes, suggesting that successful implementation requires careful design and alignment with learner needs and instructional goals.

Prior research demonstrates that gamification can improve students' engagement, motivation, and academic success (based on model knowledge). Hong and Masood (2014) studied Malaysian secondary students and found significantly higher motivation under gamified instruction than traditional methods (based on model knowledge). Budasi et al. (2020) reported that PowerPoint-based games increased motivation and enhanced the educational experience among grade-four learners in Malaysia (based on model knowledge). Similarly, Park and Kim (2021) examined the addition of game elements to online learning and observed improvements in learning outcomes (based on model knowledge). The present study examines the influence of gamification on sixth-grade students' motivation to learn mathematics using game-based platforms such as Blooket. Although situated in the United Arab Emirates (UAE), this study focuses on mechanisms timely feedback and support for autonomy and competence and on gamification elements reported across diverse international contexts, clarifying what may transfer and which cultural or infrastructural conditions matter (Sailer & Homner, 2020; Seaborn & Fels, 2014).

Significance of Study

The influence of technology, particularly gamification, on education has been overwhelmingly positive. Gamification, an educational strategy aimed at enhancing student motivation, has received extensive attention in research (Surendeleg & Murwa, 2014; Werbach & Hunter, 2012). This study aims to uncover insights that can be valuable to a wide audience, including students, educators, researchers, game developers, technologists, and policymakers.

Identifying effective teaching methodologies, such as gamification-based learning, is of great importance to educators and instructors across all educational levels. Moreover, this research provides valuable insights for game developers and technology experts. They can utilize the findings of this study to enhance student learning experiences by integrating these teaching methods into educational games and software.

Furthermore, the results of this study can inform decision-making in the education sector. By making informed decisions based on these findings, policymakers can advance mathematics education for a broader range of students. The integration of games into mathematics education not only enhances understanding of mathematical concepts but also promotes the development of skills relevant to the 21st century workforce. By incorporating elements of fun and interactivity into mathematics classes, students are more likely to retain what they learn and develop a genuine enthusiasm for learning. This enthusiasm can have significant benefits for both their academic journey and future careers.

LITERATURE REVIEW

Substantial research has explored the influence of gamification on learning (e.g., Anisa et al., 2020; Buckley & Doyle, 2014; Chapman & Rich, 2018; Jagust et al., 2017; Lufti et al., 2021; Papp, 2017).

Buckley and Doyle's (2014) study revealed that gamified learning interventions positively influenced students' learning outcomes. Furthermore, the study highlighted the variation in the impact of gamified interventions on participation which was contingent on whether the motivation was intrinsic or extrinsic. The study suggests that gamified learning interventions tend to lead to a more pronounced influence on intrinsically motivated learners. Similarly, Papp (2017) explored the implications of integrating educational computer games into learning across different student age groups. Study results demonstrated that using educational computer games positively influenced student engagement and learning outcomes across various age groups. These results highlight the effectiveness of gamification education and its potential to enhance learning outcomes, with adaptability to different age groups.

Across regions, empirical results are broadly positive but design-dependent: in Europe, a Spanish university study found that gamifying a semester-long course increased engagement, though performance effects were mixed when rewards were not well aligned with tasks (Domínguez et al., 2013). In the Americas, USA K-12 assessment practice showed increased engagement and modest performance gains, contingent on design (Attali & Arieli-Attali, 2014).

According to Jagust et al. (2017), research in gamification has also explored its impact on students' emotional domain. A systematic review of 57 journal papers indicated that 54% of these studies examined the emotional domain in the context of game-based learning, with 84% suggesting positive influences on students' motivation, engagement, attitudes, and overall enjoyment. In a separate study, Chapman and Rich (2018) investigated the influence of various game elements on motivation. The study revealed that 67.7% of participants found gamification to be more motivating than traditional course designs.

More recently, Anisa et al. (2020) investigated the impact of gamification on students' motivation in English learning and found that a game-based student response (GBSR) system supported competence, autonomy, and relatedness, increasing both intrinsic and extrinsic motivation. Teachers' creative use of Kahoot further amplified these motivational gains. In a related line of work, Lufti et al. (2021) examined the integration of computer games as a learning resource in chemistry and reported deeper conceptual understanding and higher engagement compared to non-game conditions. In K-12 assessment contexts, adding points increased engagement but did not yield meaningful improvements in test performance, underscoring the limits of extrinsic rewards and the need for task-aligned designs (Attali & Arieli-Attali, 2014).

Gamification and Learning Mathematics

Mathematics education is pivotal in equipping students with logical reasoning, critical thinking, and problem-solving skills, all of which are indispensable for success in various fields (Bhanu, 2019). However, mathematics is often perceived as challenging to master (Sedig, 2008). To address this challenge, educators have increasingly turned to gamification, a widely recognized approach in education that fosters interaction, engagement, and positive behavior, while encouraging learners to explore and expand their knowledge (Kapp et al., 2014). This integration of gaming elements into education, particularly in mathematics, has yielded promising results in enhancing students' overall performance.

For example, Bakker et al. (2015) demonstrated that mini games had the potential to significantly improve students' procedural and conceptual knowledge. Similarly, Ke and Grabowski (2007) found that those engaged in gaming, particularly in cooperative groups, exhibited superior mathematics performance. Additionally, gamification has proven effective in collecting comprehensive student learning data (Phillips & Popović, 2012).

Furthermore, Jagust et al. (2017) conducted a study focusing on the integration of game applications with instructional strategies to teach mathematics skills to fifth-grade students. The study revealed a substantial improvement in mathematics performance among experimental students compared to their counterparts in standard classrooms. Udjaja et al. (2018) revealed increased motivation and interest in learning mathematics among those taught using the game development life cycle strategy. This aligns with the findings of Abdullateef (2021) regarding the effectiveness of digital tools in developing critical thinking skills in mathematics.

Research by Geffen et al. (2016) focused on the application of gamification in popular digital learning platforms like Khan Academy and Duolingo, which are extensively used for mathematics subjects In Homeschooling environments. Results indicated that while some homeschoolers enjoyed the experience, many stated that the virtual rewards on offer were unappealing or inauthentic. Jagušt et al. (2018) investigated the effectiveness of gamified learning activities in lower primary mathematics lessons. The research revealed that the success of gamification is not solely attributable to individual game elements but rather hinges on their harmonious integration.

More and more schools are using gamification to get students interested in learning and improve their learning outcomes. Adding game-like elements to the learning process makes students more likely to participate and do well in school. On the psychological components involved, immersion, flow, and involvement are associated with games, which often boost motivation levels for those involved. This is the case even in completing tasks that were initially very challenging but were later overcome as motivation improved (López-Belmonte et al., 2020).

On the potential for learning, research by Giang (2013) revealed that using game mechanics to learn can support comprehension by up to 40%. Hence, gamification is being used more and more in schools to get students more interested and motivated. It has also been found to be effective in improving learning outcomes and retention rates, making it a valuable tool for educators. Research by Huang and Soman (2013) found that gamification can positively affect student behavior, commitment, and motivation, improving their knowledge and skills. Because of this, gamification has become an essential part of active learning, an approach that is becoming increasingly popular in education globally (Putz & Treiblmaier, 2015). It uses elements like rewards, points, competitions, and so on to help students become more self-motivated and do better in school. Therefore, gamification has the potential to make traditional ways of teaching obsolete and improve students' learning experiences. Aided by game mechanics, students can acquire knowledge and skills in a fun and engaging way, which can ultimately lead to better academic outcomes. However, Hanus and Fox (2015) argue that gamification in education may not be adequate on its own to attain the intended educational objectives. This contention is substantiated by their finding that there is a need to conduct a more thorough examination of the effectiveness of specific game elements and their practical integration, Similarly, Sailer et al. (2017) reinforced this perspective through their empirical study in 2017, underlining the necessity for a comprehensive exploration of the practical application of various game elements. In essence, both studies recommend further research be conducted to unveil effective strategies for implementing various game elements to enhance students' engagement, motivation, and overall academic performance.

The Theoretical Framework

To understand the connection between gamification and motivation, three theories will be used to help explain the results of this study: behavioral learning theory, self-determination theory (SDT), and Vroom's expectancy theory. First, 'behavioral learning theory' emphasizes the role of reinforcement and feedback in determining and reinforcing behavior (Yussif, 2022). Gamification relates these ideas by giving points, badges, and levels as rewards for doing certain tasks or reaching certain goals. These rewards are a form of positive reinforcement that encourages learners to keep working on the content and reinforces the behaviors that are wanted. To this point, Biró (2014) suggests that gamification has more factors that align with the behaviorist learning theory (advantage of positive reinforcements, minor tasks step-by-step, instant feedback, and progressive tasks) than all three of the other major concepts combined.

Second, the SDT identifies three fundamental psychological needs: autonomy, competence, and relatedness. When these needs are met, individuals become more intrinsically motivated and self-determined (Ryan & Deci, 2017). SDT emphasizes the capacity to make decisions and manage one's own life, driven by internal motivations rather than external pressures (Lopez-Garrido, 2023). This theory is closely linked to video game elements and player motivation, as players engage in virtual challenges for enjoyment, fulfilling their need for autonomy and competence. For example, Aparicio et al. (2012) argue that activities are intrinsically motivating when participants find them engaging and voluntarily participate for their own sake. Additionally, as Gee (2003) notes, many players in gamified environments prefer to play competitively and collaborate with like-minded individuals, further satisfying their need for relatedness and volition.

Third, Vroom's expectancy theory outlines motivation as an output of three key components: expectancy, instrumentality, and valence (Min et al., 2020). The theory posits that individuals are motivated by the expectation that effort will result in performance and desired outcomes (Zboja et al., 2020). This framework is significant in gamification, as it can enhance motivation by linking game points to specific behaviors, thereby clarifying the connection between effort, performance, and outcomes (Vagas & Tezi, 2021). Gamification elements such as points, badges, and scoreboards instill a sense of accomplishment and success, especially when learners have high expectations and see clear links between their efforts and rewards (Richter et al., 2014). Research findings reveal a compelling connection between students' engagement with the Blooket game and their academic performance, aligning with Vroom's theory.

OPERATIONAL DEFINITIONS

Gamification

Theoretically, gamification is defined as "using game design elements in non-game contexts." In other words, gamification is the capacity to gamify a theoretical setting to promote individual engagement and motivation by developing game components like rewards or points (Norvaisas, 2017; Tobon et al., 2020).

Table 1. Gamification components as used in the study

1. Game	2. Element	3. Design	4. Non-game context
Implies the following are key components of achieving a goal: limiting rules, providing feedback, and encouraging voluntary participation.	It helps differentiate between the concept of gamification and serious games like simulation.	The use of game design as an alternative to game-based technologies or practice.	The area of application is not limited to certain contexts.

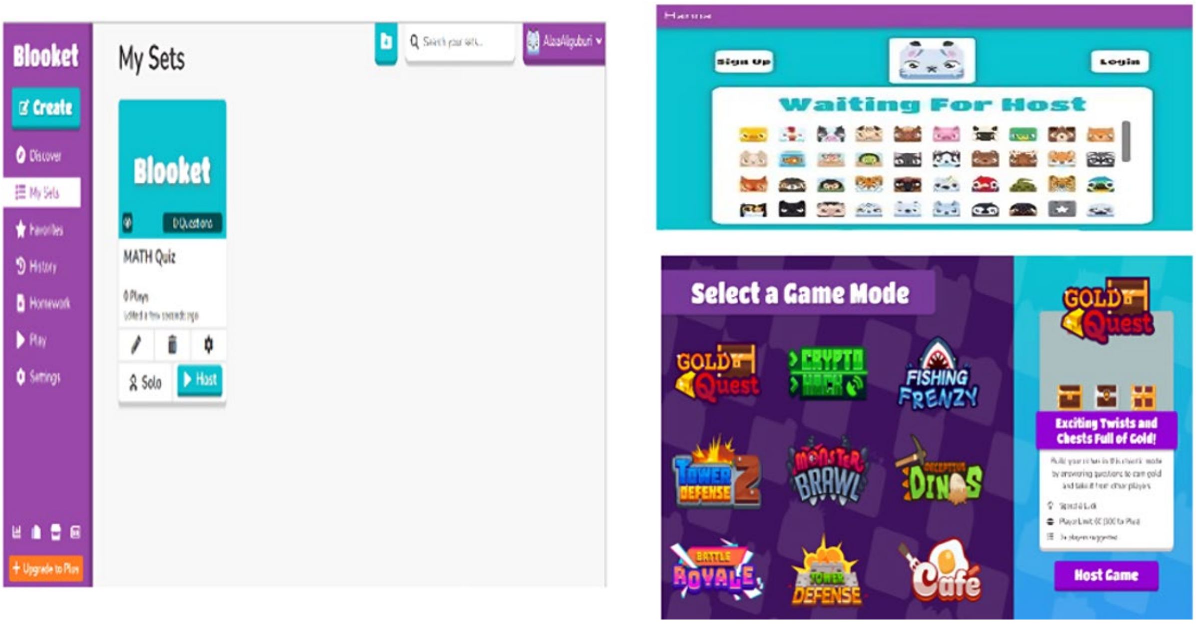

Figure 1. A screenshot from gamification application Blooket (Developed by the authors)

According to Kapp et al. (2014), the pedagogical technique is modified to include game components, in which, instead of learning goals, the teacher would give a task that players must complete to get access to the educational experiences. On the other hand, other definitions of gamification focus on the critical thinking skills often utilized in games and could be applied in non-game settings (Farber, 2013).

Table 1 shows the gamification components as used in the study.

Blooket

Blooket is a dynamic platform known for its gamification approach, featuring interactive quizzes designed to actively engage students in the classroom (James, 2022). This quiz-based game enables educators to create question sets, invite student participation, and receive responses through their devices. Blooket offers a diverse range of question sets, including pre-made options and the ability for educators to craft custom questions aligned with students' proficiency levels, subject matter, and class activities. The process involves creating an account, defining questions, adding images, setting a timer, and selecting a game mode. Instructors can customize settings and initiate the quiz, with a comprehensive report of results available after its conclusion, assisting in determining the winner (Blooket, 2022).

Figure 1 depicts a screenshot from gamification application Blooket. **Figure 2** shows a screenshot of an example of gamification activity using Blooket.

Problem Statement

Recent assessments of students' academic performance in reading, mathematics, and science (UAE Government, 2018, 2023a, 2023b), including the 2019 PISA results, reveal concerns about mathematics performance among UAE students. Students scored below the global average, with a PISA score of 435 compared to the OECD average of 489, ranking 42nd globally (UAE Government, 2019). While PISA assessments target 15-year-olds (typically grade 9 or grade 10), this study focuses on sixth-grade learners to address foundational learning gaps before they escalate into more serious performance issues.

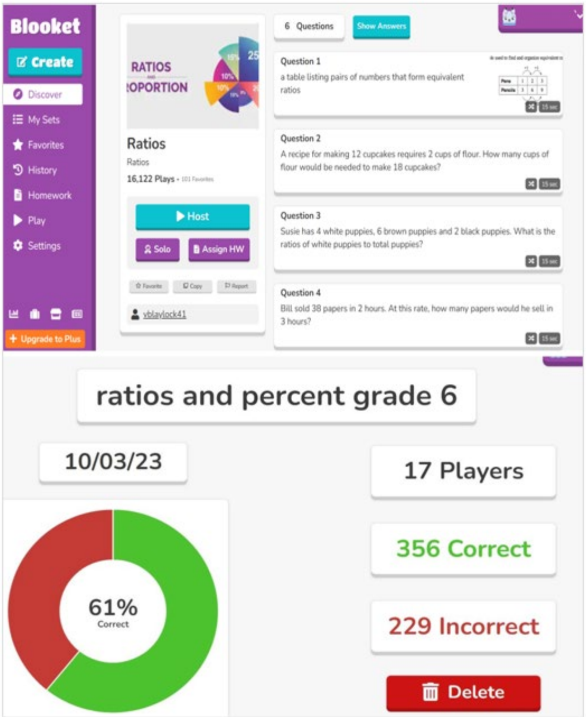

Figure 2. A screenshot of an example of gamification activity using Blooket (Developed by the authors)

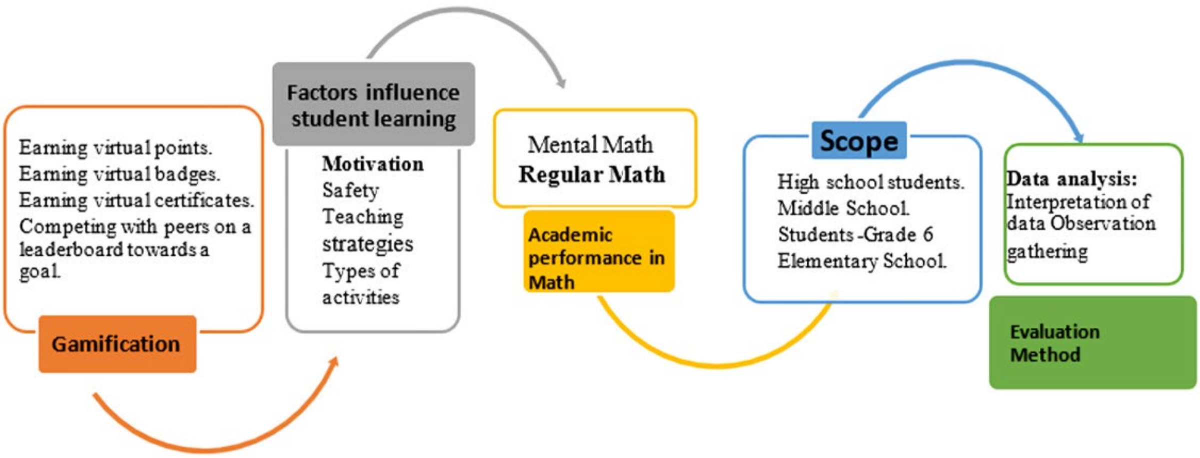

Figure 3. Research scope graph (Developed by the authors)

Additionally, the COVID-19 pandemic significantly affected the continuity of learning, particularly in STEM subjects such as mathematics. The transition to remote education and the limited availability of interactive resources contributed to decreased student engagement and weaker academic outcomes (Alshammari, 2020; Gustiani, 2020). By targeting younger learners, this study takes a proactive approach to strengthen mathematical foundations and motivation early, preparing students more effectively for future assessments and digital learning environments.

Study Objectives

This study aimed at achieving the following objectives:

- investigating the effect of gamification on sixth-grade students' learning of mathematics,
- measuring students' perception of the utility of gamification on their motivation levels, and
- highlighting the potential benefits of integrating gamification into mathematics teaching and learning. The research scope is presented in **Figure 3**.

Research Questions

To explore the effect of gamification on promoting students' learning mathematics and motivation, three questions were addressed in this study:

1. What is the potential effect of gamification on sixth-grade students' learning mathematics?
2. How do students who have used gamification perceive the utility of gamification on their motivation?
3. What are the opportunities for using gamification during the learning process?

METHOD

Participants

The participants in this study were 94 sixth-grade mathematics students in a UAE school, evenly distributed by gender (49 girls, 45 boys). The study sample, selected from one private school due to administrative constraints, comprised of 49 girls and 45 boys, organized into control and experimental groups. The decision to conduct the study in separate boys' and girls' sections aimed to minimize gender-related biases. The school had previously administered a diagnostic test, categorizing students into below-standard, standard, and above-standard performance levels. Of the 94 participants, the majority (90 students) demonstrated standard performance in mathematics. Because the sample size in the present study is relatively small and drawn from a single school, future research should include larger and more diverse samples across different school types and regions to strengthen the generalizability of the findings.

Setting and Design

This study was conducted in Ajman, UAE. The selected school is a private institution where the mathematics curriculum aligns with the UAE's Ministry of Education's mathematics standards. Hence, students at this school follow the same educational system, syllabus, textbooks, and learning resources for mathematics as their peers in other private schools governed by the UAE's Ministry of Education.

This research employs a quasi-experimental design, as outlined by Hassan (2023), wherein two participant groups are matched in terms of age, grade level, and subjects, except for the independent variables (IVs). In this experiment, one group, referred to as the experimental group, is exposed to gamification-based learning facilitated by the integration of the Blooket application. This is done to assess the presence of any potential causal relationship between gamification, students' performance in mathematics, and motivation, specifically for sixth-grade students. By contrast, the other group, known as the control group, does not receive this intervention, serving as the benchmark for comparative analysis.

In this quasi-experimental design, the primary IV is gamification, while student motivation and student mathematics learning serve as the dependent variables (DVs). To conduct the experiment, a pre- and post-test were administered to both groups of sixth-grade students. Subsequently, the experimental group underwent the designated intervention. Following this, the post-test was administered again to both groups (control and target) to compare differences in mathematics achievement based on student scores.

Additionally, to assess the effect of applying gamification on student motivation, a questionnaire was used to collect students' perceptions. This is done retrospectively to assess the influence of the IV (gamification) on the DV in this case motivation.

Data Collection

Two instruments were used for data collection

(1) a pre-/post-test and

(2) a questionnaire.

The pre-/post-test

Both the control and experimental groups underwent a standardized pre-test at the study's outset, evaluating sixth-grade mathematics skills. The pre-test measured initial academic performance.

After the integration of gamification with the experimental group, a post-test was administered to both groups, allowing a comparative analysis of their performance. The standardized, computer-based assessments lasted approximately 45 minutes and focused on the ratio unit within the sixth-grade mathematics curriculum. Tests were sourced from reputable online standard assessments aligned with the UAE's Ministry of Education's curriculum, utilizing Reveal math: K-12 math program by McGraw Hill.

The motivation questionnaire

A motivation questionnaire (MQ), in the form of survey instruments, was deployed to measure the motivation level of the experimental group. The questionnaire was adapted from a case study conducted by Benhadj et al. (2019) that investigated 'the impact of Kahoot! on students' engagement, motivation, and learning outcomes'. The researchers employed the questionnaire to measure motivation and engagement in a game-based learning environment. The questionnaire encompasses three sections:

(1) demographics,

(2) students' perceptions towards the impact of Blooket on their motivation, and

(3) open-ended questions requesting students to share their experiences of integrating gamification into their learning journey.

Validity and Reliability of Instruments

1. **The pre-/post-test** and the post-treatment questionnaire (MQ) were all validated, and reliability was established. Firstly, mathematics tests (pre- and post-tests) were standardized tests taken from Reveal math: K-12 math program by McGraw-Hill. This is the accredited mathematics resource for the UAE's Ministry of Education in the UAE for grade 6 students (Tawzea, 2023). Additionally, the test content validity was reviewed by the academic head and head of mathematics at the selected school.
2. **The MQ** was reviewed and validated by five experts with different educational backgrounds including mathematics, technology, and psychology. Feedback included recommendations to refine the language of certain items and to rephrase questions in some sections. On the other hand, the questionnaire's reliability was calculated and yielded a Cronbach's alpha value of .810, which is considered a strong indicator of questionnaire reliability. The final revised version of this questionnaire aimed to measure the utility of gamification, its motivational influence, and learning benefits in mathematics.

Treatment

All students received study materials and completed a pre-test in mathematics to ensure equity. The control group followed traditional teaching methods for the ratio unit, while the experimental group received a gamified intervention using the Blooket application. Both groups had 12 sessions covering topics such as understanding, graphing, solving, finding percentages, and comparing ratios.

Gamification elements were integrated into each lesson, and digital formative assessments were conducted using the Blooket game. The 'crypto hack' mode motivated students to answer questions accurately and compete for points. After completing the 12 sessions, all participants took a post-mathematics test. Participants in the experimental group provided feedback through a questionnaire evaluating the utility of gamification, its impact on motivation, and its benefits for learning mathematics. To ensure equity, all students received the necessary study materials and completed a pre-test in mathematics.

Each group employed different learning approaches for the assigned unit, as illustrated in **Table 2**. The control group followed traditional teaching methods for the ratio unit, whereas the experimental group received an intervention involving the seamless integration of gamification

Data Analysis

Two types of statistical analyses were used. First, descriptive statistics were utilized to identify any differences in mathematics test scores between the control and experimental groups. Additionally, they were used to investigate students' opinions regarding the impact of gamification, specifically through the Blooket game, on learning mathematics. Finally, to categorize responses, data were collected through an open-ended

Table 2. Studying approaches for participant groups

Learning approach information	Control group	Experimental group
Students gender	Boys and girls	Boys and girls
Core learning mathematics content	Ratio unit includes five lessons: L.1. Understand ratios (compare two quantities), L.2. Find equivalent ratios, L.3. Solve ratio problems, L.4. Find the percentage of a number, L.5. Compare ratio relationships.	Ratio unit includes five lessons: L.1. Understand ratios (compare two quantities), L.2. Find equivalent ratios, L.3. Solve ratio problems, L.4. Find the percentage of a number, L.5. Compare ratio relationships.
Learning resources	Printable worksheets	Blooket activities provide multiple-choice questions in different themes and challenges via the Blooket application.
Instructional strategy	Traditional model	Gamified learning
Instructors	One instructor for all students	One instructor for all students
Timeline	12 sessions	12 sessions

Table 3. Tests of between-subjects effects

Source	Type III sum of squares	df	Mean square	F	Significance
Corrected model	620.477[a]	2	310.239	19.375	< .001
Intercept	867.025	1	867.025	54.147	< .001
Pre	112.798	1	112.798	7.044	.009
Pre-math standard test out of 20					
Group	451.513	1	451.513	28.198	< .001
Error	1,457.140	91	16.013		
Total	13,584.000	94			
Corrected total	2,077.617	93			

Note. Dependent variable: Post-math standard test out of 20; [a]R squared = .299 (adjusted R squared = .283)

Table 4. ANOVA assessment of the differences between the control and experimental groups

Source of variation	Sum of squares	df	Mean square	F	p-value	F critical
Between groups	302.76	2	151.38000	7.751848	0.000753	3.090187
Within groups	1,894.24	97	19.52825			
Total	2,197.00	99				

question presented to students in the experimental group. Secondly, an analysis of variance (ANOVA) was used to assess the significance of these differences (the study uses 0.05 as the standard of measure for statistical significance).

RESULTS AND DISCUSSION

To answer question 1, "What is the potential effect of gamification on sixth-grade students' learning of mathematics?", ANOVA showed a significant difference favoring the experimental group (see **Table 3** and **Table 4**).

As seen in **Table 4**, two primary sources of variation were considered: 'pre math-standard test out of 20' and 'group.' 'Pre math-standard test out of 20' had a significant impact on post-test scores (F [1, 91] = 7.044, p = 0.009), emphasizing the importance of initial mathematical proficiency. 'Group' (control vs. experimental) had a highly significant effect on post-test scores (F [1, 91] = 28.198, p < 0.001), demonstrating substantial differences between the groups, accounting for pre-test scores.

ANOVA analysis indicates that the between-groups variation is statistically significant, F (2, 97) = 7.75, p = 0.000753), with the calculated F-statistic exceeding the critical F-value.

Table 5 emphasizes the statistical significance of the differences between the control and experimental groups in math test scores.

Thus, the ANOVA results supported the hypothesis that the integration of gamification in teaching enhances students' understanding of mathematical concepts and skills. Moreover, it is expected that students

Table 5. Participants perceptions of the utility of gamification on their motivation for learning

Item	M	SD	Valid percentage				
			SDA	D	N	A	SA
Gamification allows for staying focused in class.	4.3	0.9	2.9	2.9	2.9	43	49
Gamification has given me the chance to share my ideas in math with my teacher	4.1	1.0	2.9	5.7	14	37	40
Gamification helps me learn better at math.	4.0	1.0	2.9	2.9	23	34	37
Gamification encourages me to competitively interact in class.	4.5	0.8	-	2.9	8.6	29	60
Gamification enhances my perception of the role of games in learning math.	4.2	0.7	-	-	17	46	37
Gamification increases my intrinsic motivation for learning	4.2	1.0	2.9	5.7	8.6	37	46
I feel comfortable when interacting online via gamification.	4.1	1.3	8.6	5.7	5.7	29	51
The online activities shared on Blooket are diverse	4.2	0.8	-	2.9	11	49	37
The online activities shared on Blooket are interesting	4.1	1.0	-	8.6	14	31	46

Note. Gamification in this study refers to the use of Blooket gaming activities in learning math; M: Mean; SD: Standard deviation; SDA: Strongly disagree; D: Disagree; N: Neutral; A: Agree; SA: Strongly agree

Table 6. Open-end question analysis: The impact of gamification on learning

Themes	Frequency
Positive impact on learning	19
Motivation and engagement	7
Social interaction	3
Negative impact on learning	2

who engage in these digital competition games will demonstrate quicker mathematics abilities compared to their peers in the same grade who do not participate in such activities.

To answer question 2, "How do students who use gamification perceive the utility of gamification on their motivation?", the results of the questionnaire items showed positive perceptions of the utility of gamification in increasing motivation for learning (see **Table 5**). Mean scores of all items range from 4.0 to 4.5 on a 5-point Likert scale extending from strongly disagree (1) to strongly agree (5) indicating high positive perceptions.

Looking into the percentages, about 80.0% of students agreed or strongly agreed that gamification (the Blooket game) encourages competitive interaction in class (mean [M] = 4.5, standard deviation [SD] = 0.8). The relatively low standard deviation of 0.8 indicates consistent agreement among respondents. Similarly, 80% of students (agree and strongly agree) feel comfortable when interacting online via the Blooket game (M = 4.1, SD = 1.3) which is positively high. Likewise, 92% of students agreed or strongly agreed that gamification helps them stay focused on class (M = 4.3, SD = 0.9).

Furthermore, 77.0% of students found the online gamification activities interesting (M = 4.1, SD = 1.0) and 83.0% of students reported a positive impact on their intrinsic motivation for learning (M = 4.2, SD = 1.0). Similarly, 83.0% of students agreed that Blooket enhances their perception of games in mathematics learning (M = 4.2, SD = 07) suggesting relatively consistent agreement. A significant portion (86.0%) of students agreed or strongly agreed that gamification provides an opportunity for students to share their ideas with their teachers, resulting in an (M = 4.1, SD = 1.0). Additionally, 71.0% of students agreed or strongly agreed that gamification helps them learn better in mathematics (M = 4.0, SD = 1.0).

To conclude, results showed that students who used gamification as part of their learning hold positive perceptions towards various aspects of gamification. This includes its impact on learning, motivation, and the diversity of online activities. These findings align with the research hypothesis that the incorporation of gamification-based learning into the sixth-grade mathematics curriculum is anticipated to increase students' motivation to learn mathematics.

To answer the third research question, "What are the opportunities of using gamification during the learning process?", answers to an open-ended question were collected from the experimental group. Subsequently, responses were coded and categorized into themes, providing insights into the effects of gamification on learning experiences. This coding was an inductive process following Corbin and Strauss' (1990), and Saldana's (2015) qualitative data analysis approach (see **Table 6**).

As can be seen from **Table 6**, the coding of responses to the open-ended question resulted in 3 themes indicating the positive effect of gamification on learning. Nineteen participants reported that gamification positively influences their learning. Similarly, seven participants reported that gamification boosts motivation

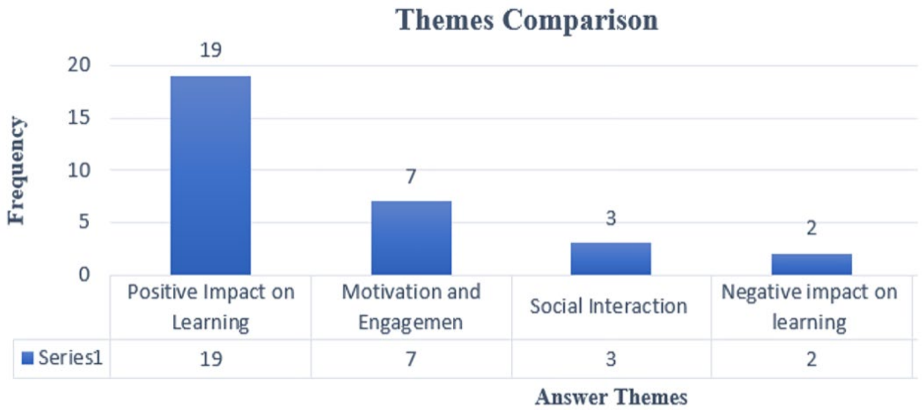

Figure 4. The impact of gamification on learning as reported by experimental group participants (Developed by the authors)

and engagement in the learning process. In addition, three students reported that gamification supports social interaction, and enhances their learning experience.

The qualitative responses collected from the student survey align closely with the thematic analysis of the open-ended question, reflecting four primary areas: positive impact on learning, motivation and engagement, social interaction, and negative impact on learning (**Figure 4**).

Positive impacts on learning were identified in several student reflections. For example, one of the participants stated that, "Blooket helped me understand multiplication and division better," indicating improved conceptual understanding through repeated gameplay. An additional participant reported that, "The Blooket game is amazing and helps me understand Math better than before," highlighting the perceived instructional value of the platform. Similarly, a third participant commented that, "It is very nice, it helps me to learn more math," affirming the tool's usefulness in reinforcing mathematical skills. These responses demonstrate that gamified digital tools like Blooket can support learners in building core academic competencies.

Motivation and engagement also emerged as significant benefits of gamification. One of the participants expressed his feelings as, "Yes, I think it makes me happier and want to learn more," reflecting increased emotional investment in learning activities. Additionally, another participant shared that, "I love to play Blooket because it helps me concentrate on math," indicating improved focus and enthusiasm during lessons. Furthermore, one of the participants stated, "Personally, I feel it is like a game, simple yet distinctive, when used in a mathematics lesson. I feel very excited when it is part of the class", illustrating internal motivation and emotional engagement. Finally, one participant also expressed feeling "excited and empowered," particularly appreciating the interactive nature and accessibility of Blooket's questions. Such comments reinforce the link between enjoyment and cognitive focus in game-based learning environments.

In terms of social interaction, one of the participants noted that, "Blooket helps me learn and have fun at the same time. It also helps me interact with others through online learning games," suggesting that the platform serves as a medium for both academic and social learning. Another participant elaborated that, "I feel excited and powerful when I play it and join it, happy and I like the questions they put. I have fun while playing it. I really like Blooket, easy to play, easy to join. I can play it with my friends, and you can use it in all subjects," expressing how the tool supports enjoyable peer-based interactions across disciplines. These reflections confirm Blooket's role in fostering collaboration and social engagement within a digital learning environment.

Although the majority of responses were positive, a few reflected a negative impact. For example, one of the participants acknowledged a feature of interest but raised concern about pacing, stating, "The hack option was nice but it [was] too fast to answer the question," pointing to how time constraints may hinder performance. Another participant stated that, "I don't like Blooket," offering a general negative view without further context. These responses suggest that while gamification benefits many, it may not be universally engaging or accessible, emphasizing the need to adapt such tools to diverse learner preferences and experiences.

Overall, the open-ended responses validate the structured survey findings and suggest that Blooket positively contributes to learning, motivation, and social dynamics in mathematics classrooms. At the same time, they underscore the importance of thoughtful implementation to ensure inclusiveness and sustained learner engagement.

key findings demonstrated that the integration of gamification, specifically via the Blooket game, into mathematics lessons significantly improved mathematics performance. Students in the experimental group achieved notably higher post-test mathematics scores (M = 13.5) compared to their peers in the control group (M=8.8), accounting for initial differences in pre-test scores. This confirms the effectiveness of gamification in improving students' understanding of mathematical concepts, substantiating the research hypothesis.

Furthermore, in order to investigate the level of impact of the treatment on the experimental group, the effect size was calculated based on the experimental group's post-test mean (M = 13.5, SD = 4.8, n = 45) and the control group's post-test mean (M = 8.8, SD = 3.3, n = 49), the pooled SD was 4.09. The calculation yielded d = (13.5 - 8.8) / 4.09 = 1.15, which represents a very large effect according to Cohen's (1988) benchmarks who suggested that benchmarks as small, medium, or large based on d = 0.2 (small), d = 0.5 (medium) and d = 0.8 or larger (large). That means the effect size of d = 1.15 is large showing that the intervention had a large effect on students' mathematics performance in post-test experimental group compared to the control group.

Moreover, the analysis of the closed-ended items in the questionnaire revealed that students in the experimental group held positive perceptions of gamification's impact on their motivation and learning experiences. They reported increased concentration in class, improved levels of intrinsic motivation for learning mathematics, comfort with online interaction, and a positive assessment of the diverse and engaging online activities on Blooket. Additionally, qualitative data from open-ended questions highlighted several beneficial aspects of gamification, including improved comprehension of mathematics concepts, enhanced motivation, and increased social interaction.

Results reveal notable differences in mathematics performance between the experimental and control groups, both before and after the gamification intervention. The 'control' group displayed an average pre-test math score of 6.8 (out of 20), indicating some variability (SD = 2.97). After the intervention, the average math score increased to 8.8, with heightened variability (SD = 3.3). On the other hand, the 'experimental' group had an average pre-test math score of 7.4, with a standard deviation of approximately 2.6. After the gamification intervention, the post-test average math score significantly rose to 13.5, accompanied by a broader range of scores (SD = 4.8). In addition, ANOVA analysis was employed to compare math test scores between the control and experimental groups. The analysis revealed a significant impact on post-test scores $F(1, 91) = 7.044$, $p = 0.009$, emphasizing the importance of initial mathematical proficiency. 'Group' variables of (control vs. experimental) had a highly significant effect on post-test scores $F(1, 91) = 28.198$, $p < 0.001$, demonstrating substantial differences between the groups, accounting for pre-test scores.

Study results align with motivational theories, including Skinner's behavioral learning theory (Skinner, 1984), showcasing the positive influence of gamification on behavior, motivation, and the learning environment. Specifically, the findings revealed a notable consistency with Skinner's emphasis on consequences shaping learning, as observed through positive changes in the participants' behavior. The participants' motivation suggests that gamification acts as an internal reinforcement for learning, rendering learning more enjoyable. Social elements, such as sharing ideas with the teacher and engaging in competitive interactions, reinforce Skinner's perspective on the importance of social aspects in learning.

Moreover, the study aligns with the SDT formulated by Ryan and Deci (2017). Integrating gamification with the experimental group provided students with autonomy in their learning choices, opportunities for competence development through engaging and challenging content, and fostered relatedness through social interaction and collaboration.

Responses to the questionnaire aligned with the three main factors of SDT, thereby increasing students' motivation toward learning, which positively impacted their performance in mathematics based on the significant findings of the post-test results for the experimental group. Scholars such as Gee (2003) and

Francisco-Aparicio et al. (2013) have conducted research on gamification that yielded results consistent with this study, underscoring the connection between video game elements and motivation as proposed by SDT.

Similarly, findings aligned with Vroom's 'expectancy theory' (Zboja et al., 2020), positing that individuals are motivated by the expectation that effort will result in academic performance and students' engagement with gamification as shown in this study.

The post-test results indicate a significant difference in scores, with the experimental group exhibiting an average of 13.7, underscoring the impact of the Blooket game on students' expectations of effort leading to improved performance. Further substantiating these outcomes are survey responses that identify students' perceptions of the effectiveness of gamification. Notably, survey item 3, 'Playing Blooket helps students learn better at mathematics,' underscores their belief that efforts in the game contribute meaningfully to improved learning outcomes. Additionally, the survey elicits insights into the valence component of Vroom's theory, with item 6, 'The Blooket game increases intrinsic motivation for learning,' suggesting a positive value attributed to the outcomes associated with engaging in the game. In essence, these findings emphasize the motivational influence of gamification, aligning with Vroom's expectancy theory and highlighting the interplay between student effort, academic performance, and the perceived value of outcomes. This alignment with 'expectancy theory' is further supported by studies conducted by Blohm and Leimeister (2013), and Richter et al. (2014). These studies, which specifically examined the relationship between effort, performance, and outcomes, closely mirror the connections identified in our study.

Studies that look at the learning impact of gamification in other academic subjects yield similar results. Research conducted by Lufti et al. (2021) on the integration of computer games in Chemistry education, found that computer games have the potential to enhance student learning outcomes and increase engagement in the educational process, despite the difference in academic context. The results of this study align with the findings of similar studies such as Anisa et al. (2020) which revealed that students experienced a feeling of competence, independence, and relatedness through GBSR, leading to heightened intrinsic and extrinsic motivation.

Additionally, the findings of this study aligned with the study undertaken by Chapman and Rich (2018), which revealed that 67.7% of those in attendance at a business course found gamification to be more motivating than traditional course designs. While this study explored the influence of gamification on motivation in a broader context, it bears similarities to an investigation conducted by Buckley and Doyle (2014), which examined the relationship between gamification and motivation. The overarching conclusion drawn from these studies is that gamified learning interventions have a positive impact on students' learning outcomes, especially among those who exhibit intrinsic motivation. Conversely, the effects on students with extrinsic motivation exhibit variations.

Framework for Gamification Integration into Teaching

For teachers to integrate gamification effectively, considering resource constraints and student diversity, researchers suggest the following framework. This framework consists of three simple phases. Nevertheless, researchers recommend that a more detailed framework should be developed and validated in a future research study.

1. **Planning:** The teachers should start planning by defining clear, smart learning outcomes for the game to be used. In addition, teachers should make sure they understand students' needs and preferences before writing the outcomes. Once the outcomes are developed, the teacher should look for available resources to be used to design or build the gamification activities.
2. **Design and apply:** Based on the outcome for the game, the elements should be selected. Make sure they are relevant and straightforward such as rewards points, level, challenges. These elements should be aligned with course content and outcomes., team challenges).
3. **Review and improve:** After using the game, collect feedback from learners and reflect on what worked well and what did not. Based on the feedback, make your revisions and adjustments for future game use.

CONCLUSION

The study provides actionable insights for educators and curriculum designers to leverage gamification for improved learning outcomes in mathematics education for sixth-grade students. The study highlighted the following:

1. A positive correlation between gamification and improved mathematics performance for sixth-grade students. This research supports the incorporation of gamification into the sixth-grade mathematics curriculum.
2. Gamification tools, such as Blooket, can guide educators in selecting and integrating technology-based platforms.
3. Practical strategies for increasing student engagement and participation, making learning more interactive and enjoyable.
4. The research highlights the importance of tailoring gamified elements to accommodate different learning preferences, promoting a more inclusive and effective learning environment.

Recommendations

The findings advocate for educators to consider gamification in instructional strategies for improved mathematics learning outcomes and a motivating learning environment. The study suggests the need for further research to explore the long-term benefits of gamification in education.

Based on the study's findings, researchers recommend the following:

1. Encouraging educators and policymakers to incorporate gamification into mathematics instruction. This proactive approach can potentially enhance student motivation and overall learning experiences.
2. Diversification of learning resources through gamification. Integrating gamification into online activities accommodates diverse learning styles, fostering motivation and positively influencing students' performance.
3. Prioritizing future research efforts in conducting longitudinal investigations into the sustained effects of gamification on student performance in mathematics and ongoing motivation. This extended inquiry will offer valuable insights into the long-term impacts on mathematics education.
4. Mixed methods data collection techniques including qualitative tools such as focus group interviews, and classroom observations should be incorporated in future research to get deeper understanding of learner behavior, engagement, and contextual dynamics in gamified classroom environments.
5. Future research should examine the cost-effectiveness, realistic scalability, and implementation difficulties of gamification in actual classroom settings.
6. Longitudinal Studies in future should be considered to monitor motivational and attainment outcomes over lengthy periods of time to gain a better understanding of the long-term effects of gamification on learning.

Hanus and Fox (2015) argue that gamification in education may not be adequate on its own to attain the intended educational objectives. This contention is substantiated by their finding that there is a need to conduct a more thorough examination of the effectiveness of specific game elements and their practical integration. Similarly, Sailer et al. (2017) reinforced this perspective through their empirical study in 2017, underlining the necessity for a comprehensive exploration of the practical application of various game elements. In essence, both studies recommend further research be conducted to unveil effective strategies for implementing various game elements to enhance students' engagement, motivation, and overall academic performance.

Limitations and Future Directions

As with any educational research conducted within a bounded context, this study includes certain limitations that must be acknowledged.

1. First, participation in the post-intervention survey was voluntary, and not all students in the experimental group chose to complete it. This may have introduced a self-selection bias, as

respondents could be those with stronger opinions or more favorable experiences, potentially skewing the results. While the data collected offers meaningful insight, it may not fully represent the perspectives of the entire experimental group.

2. Second, the study was conducted within the context of a single private school. While this setting allowed for in-depth implementation and monitoring of the intervention, it also limits the external validity of the findings. Educational settings in the UAE vary in terms of curriculum, student demographics, and institutional practices. As such, caution is warranted when generalizing the results to public schools or to the broader UAE school system. Nevertheless, this study provides a valuable starting point for understanding the potential impact of gamification in mathematics education. Future research could strengthen generalizability by including a more diverse sample across different school types and regions.
3. Third, as the homogeneity of the participant sample in this study hindered the analysis of cultural influences such as cultural perceptions, student attitudes, institutional expectations, and society norms impact the implementation and effectiveness of gamification, cross-cultural comparisons should be used in future studies to examine these factors.
4. Fourth, although teacher readiness, including training, confidence, and pedagogical beliefs, plays a critical role in the long-term adoption of gamification, this study did not evaluate or focus on these factors, future research should look into how these factors affect results and implementation.

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