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Original Article

The Impact of Reward Types and Leaderboard Use in Kahoot-Based Math Learning: A Quasi-Experimental Study

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ABSTRACT

Background: Motivation plays a critical role in student engagement and learning outcomes. However, limited research has compared the effects of tangible versus intangible rewards in game-based learning environments. This study aimed to investigate the comparative effects of tangible and intangible rewards on students' motivation and engagement when using the Kahoot platform for mathematics education.

Methods: This study utilized a quasi-experimental approach with pre-test and post-test assessments, conducted among 277 elementary students between September 2020 and June 2021. Using convenience sampling, participants were assigned to three groups: a control group (95 students), an experimental group using Kahoot with intangible rewards (90 students), and a second experimental group using Kahoot with both tangible and intangible rewards (92 students). The intervention was carried out over a six-week period. Content validity was confirmed using the Content Validity Ratio (CVR), with all items exceeding 0.80 and an overall agreement coefficient of 0.84. The reliability was verified with a test–retest correlation of 0.70.

Results: The comparative analysis revealed that Kahoot-based learning was more effective than social network-based instruction. Furthermore, the group that received both tangible and intangible rewards demonstrated significantly greater learning gains compared to those who received only intangible rewards ($P<0.05$).

Conclusion: The findings support the use of gamified platforms such as Kahoot to enhance mathematics learning, particularly when leaderboard-based reward strategies are employed. Future research should investigate the long-term effects of different reward types and their influence on sustaining student motivation.

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Keywords: Reward; Kahoot, Students, Gamification, Leaderboard, Motivation, Mathematics

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Introduction

Mathematics is widely regarded as one of the most important subjects in school curricula, and mathematical competence plays a vital role in fully engaging with everyday life (1). However, students' achievement in mathematics remains a significant issue, as research indicates that interest and active involvement in the subject are key predictors of success (2). Educators often struggle to sustain student motivation, which is strongly associated with academic outcomes (3). Gamification offers a solution by incorporating game elements such as points, badges, and leaderboards into educational contexts to enhance motivation and engagement (4, 5). Skinner's behaviorism theory, emphasizing positive reinforcement, underpins the gamification approach in this study, where students are motivated through ranking and rewards (6). Elements like competition, incentives, and leaderboard mechanisms enhance the attractiveness of learning by providing external incentives. Leaderboards, in particular, establish a competitive framework that has been shown to increase engagement and drive motivation, ultimately contributing to better academic performance (6-8).

Rewards—whether tangible or intangible—are essential components of gamified learning, helping motivate students to achieve educational objectives and sustain their involvement (9, 10). Previous studies indicate that rewards contribute positively to student interaction, performance, and motivation (11, 12). However, the combined influence of tangible and intangible rewards within online gamified settings remains insufficiently explored, especially regarding their effects on intrinsic motivation and overall engagement.

Kahoot, a widely adopted game-based instructional tool, integrates these gamification features into classroom activities. Studies have reported that Kahoot boosts learning by increasing enjoyment, decreasing fatigue, and promoting greater concentration and involvement among students (13, 14). The platform has consistently been associated with higher engagement, stronger motivation, and improved academic performance (15). Moreover, its continued use has been linked to enhanced comprehension and long-term retention across a range of subjects (16, 17).

Although previous studies have demonstrated that tools like Kahoot, leaderboards, and reward systems can enhance student learning, little is known about how tangible and intangible rewards differ in their effects within a leaderboard setting, particularly in mathematics education. Existing evidence offers inconsistent conclusions regarding which type of reward is more beneficial, indicating that the effectiveness of a reward may depend on its characteristics and how well it aligns with the learning environment (18, 19). Therefore, this study sought to compare the effects of tangible versus intangible rewards on student motivation and engagement when using Kahoot for mathematics learning, with special attention to how these rewards influence high-achieving students.

Methods

Study Design and Setting

This study employed a quasi-experimental design with a pre-test and post-test control group to evaluate the effects of combining tangible and intangible rewards on learning among sixth-grade students using the Kahoot platform. The study took place in Shabestar, East Azerbaijan Province, Iran, during September 2020 to June 2021.

Participants and Sampling

The study population consisted of 277 sixth-grade students from elementary schools in Shabestar, Iran. A convenience sampling method was used to recruit students from different areas, resulting in a sample comprising 32% girls and 68% boys. The participants were randomly assigned to three groups: a control group using social networks for assignments (95 students), an experimental group using Kahoot with intangible rewards (90 students), and a second experimental group using Kahoot with both intangible and tangible rewards (92 students). The sample size was determined According to the meta-analysis by Mazeas and his colleagues (20), gamified interventions on physical activity yielded small-to-medium effect sizes (Hedges' g ≈ 0.42). Using the standard formula for two independent groups, with α=0.05, power=0.80, and an expected effect size of g ≈ 0.3–0.4, the required sample size was estimated at approximately 85–90 participants per group.

$$n = \frac{2 \times (Z_{\alpha/2} + Z_{\beta})^2}{d^2}$$

Intervention/Procedures

The teaching intervention was developed using gamified learning strategies through the Kahoot platform. Sixth-grade math content was delivered through interactive quiz-based activities. Each class started with a brief teacher explanation of the topic, after which students completed Kahoot exercises. Learners answered multiple-choice questions independently and were given immediate feedback on each item. After every round, a leaderboard was displayed to enhance motivation and encourage friendly competition. The intervention utilized three distinct reward approaches, and the groups varied solely in the platform and reward system used, while receiving identical instructional materials:

Control Group (Social Network–Based Learning)

A total of 95 students completed mathematics exercises through social networking platforms and submitted photos of their completed work to the teacher by the designated deadline without any gamification features, feedback, or reward systems.

First Experimental Group (Intangible Rewards)

This group included 90 students who practiced using the Kahoot platform and received non-material incentives such as points and leaderboard placements.

Second Experimental Group (Tangible + Intangible Rewards)

Comprising 92 students, these participants also used Kahoot but were additionally provided with tangible rewards—such as notebooks, pencil cases, and books—for achieving top leaderboard positions.

Educational Design

The teachers in the experimental groups (nine in total) were trained on how to use Kahoot and its key functions through instructional tutorial videos. Due to COVID-19 restrictions, they prepared and shared pre-recorded video lessons covering four mathematics topics: multiplication and division of fractions, percentages and proportions, ratios and proportions, and probability. All groups received identical video lessons and assignments, and the Kahoot activities were aligned with the mathematics exercises in the students' textbooks. After uploading the instructional videos, the teachers sent students the links to the related Kahoot quizzes (Figures 1 and 2). Students were expected to open the link within the assigned time period and complete the questions.

Kahoot automatically recorded students' answers, enabling the teacher to monitor their participation, accuracy, number of unanswered items, and individual rankings based on total points (Figure 3). No penalties were applied for incorrect answers, and scores—determined by accuracy and response speed—ranged from zero to 10,000 points. In the "Kahoot with Leaderboard" group, students who ranked highest were acknowledged and rewarded with small prizes such as notebooks, pencil cases, and books, whereas students in the other groups did not receive applause or rewards.

Tools/Instruments

A researcher-developed pre-test and post-test were utilized to measure students' learning gains. Both assessments contained short-answer and extended-response items and were distributed and collected via an online platform.

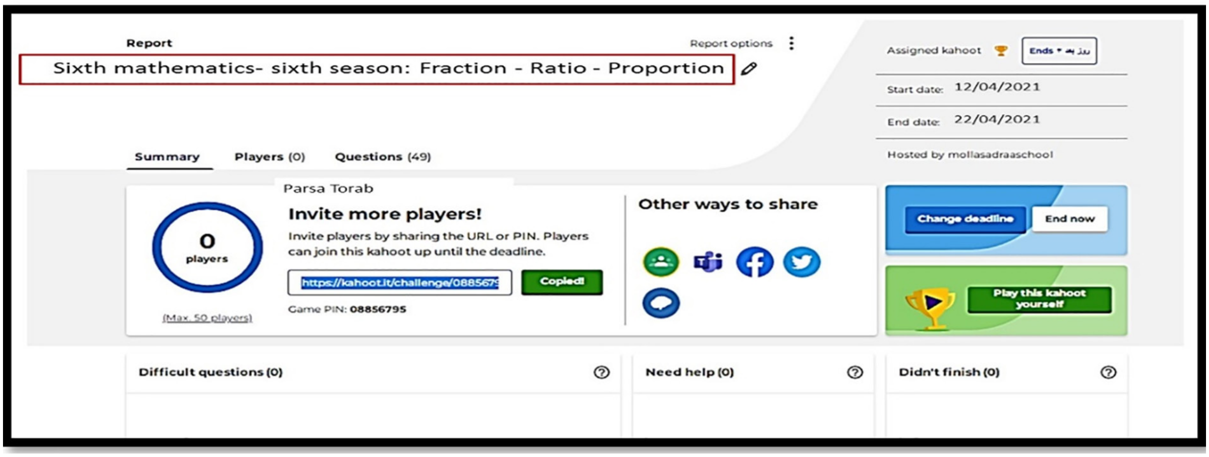


Figure 1: Links created for each exercise

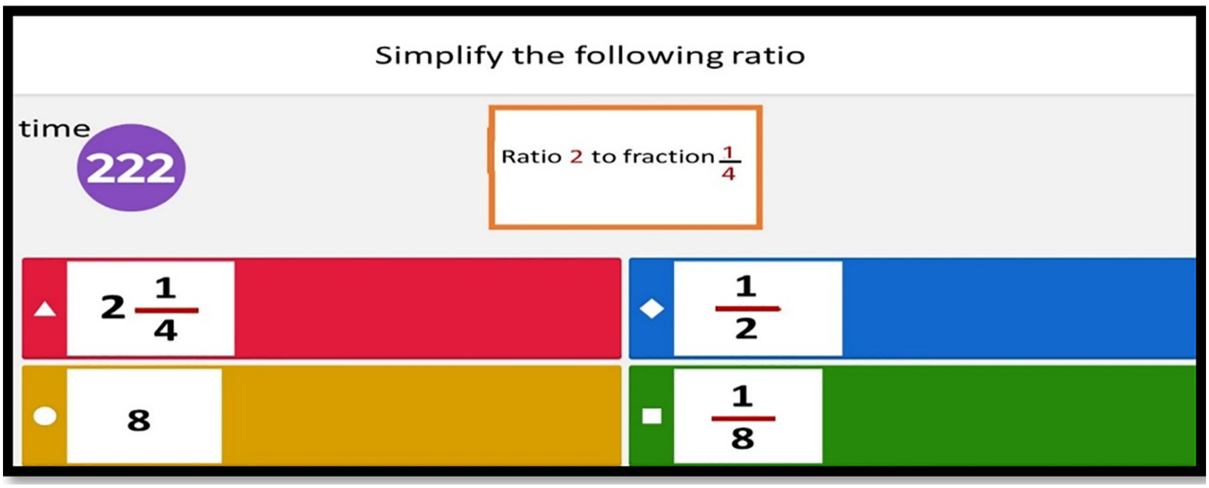
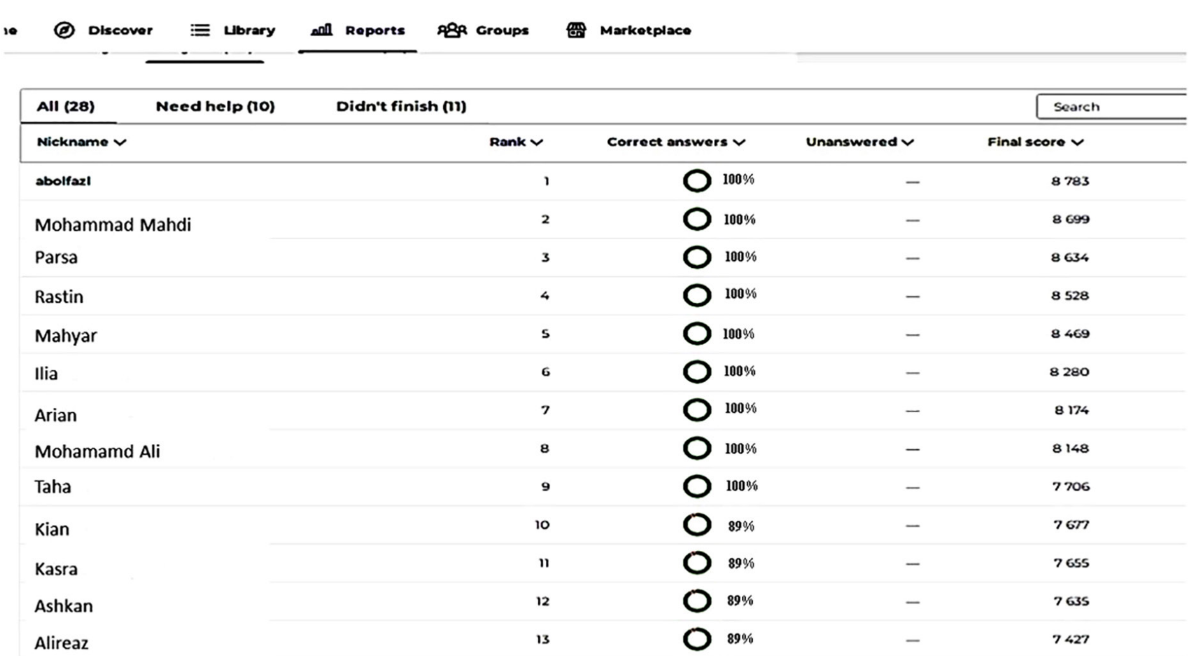


Figure 2: Sample Kahoot question adapted from the sixth-grade mathematics textbook



Nickname	Rank	Correct answers	Unanswered	Final score
abolfazl	1	100%	—	8 783
Mohammad Mahdi	2	100%	—	8 699
Parsa	3	100%	—	8 634
Rastin	4	100%	—	8 528
Mahyar	5	100%	—	8 469
Ilia	6	100%	—	8 280
Arian	7	100%	—	8 174
Mohamamd Ali	8	100%	—	8 148
Taha	9	100%	—	7 706
Kian	10	89%	—	7 677
Kasra	11	89%	—	7 655
Ashkan	12	89%	—	7 635
Alireaz	13	89%	—	7 427

Figure 3: Report of Students' Performance in Kahoot

The learning outcomes examined in this study focused on students' abilities to solve grade-appropriate mathematics problems, apply conceptual knowledge, and exhibit procedural fluency.

Validity and Reliability – Content validity was established through review by 20 expert teachers, resulting in a Content Validity Ratio (CVR) of 0.84. Test reliability was evaluated using the test–retest approach, producing a reliability coefficient of 0.7.

Data Collection

Data were collected through pre-test, post-test, and delayed post-test assessments. The pre-test occurred before the intervention, and the post-test was conducted 10 days after the intervention's conclusion. For assessing retention, a delayed post-test was administered six months after the study. In the experimental groups, students' responses, correct answer rates, and leaderboard ranks were recorded in Kahoot, with points allocated based on response accuracy and speed. Sessions were conducted twice weekly for six weeks, with each lasting around 45 minutes.

Data Analysis

Both descriptive and inferential statistical techniques were used to analyze the dataset. Descriptive analyses involved computing means, standard deviations, and frequency distributions for each group. To determine whether the type of reward influenced post-test outcomes while accounting for initial performance differences, a one-way Analysis of Covariance (ANCOVA) was first performed, with pre-test scores entered as the covariate.

Prior to performing the ANCOVA, major assumptions were checked, including the normality of residuals (evaluated through the Shapiro–Wilk test and Q–Q plots), homogeneity of variances (Levene's test), linearity between the covariate and dependent variable, and homogeneity of regression slopes across groups. Violations in the assumptions of homogeneity of variances and regression slopes were identified, which invalidated the ANCOVA results.

To address these violations, a Generalized Linear Model (GLM) with robust estimators (Huber–White) was employed. The model used a normal distribution with an identity link function and included pre-test scores as a covariate. Robust standard errors were applied to account for heteroscedasticity. Estimated marginal means were calculated for each group, and pairwise comparisons were conducted using LSD adjustment (Least Significant Difference test) to identify specific group differences. All statistical analyses were performed using IBM SPSS Statistics V. 22, with the significance level set at $\alpha=0.05$.

Ethics - Prior to data collection, all participating students and their legal guardians received clear and age-appropriate information describing the purpose of the study, the nature of the learning activities, potential benefits, expected time commitments, and the voluntary nature of participation. Written informed consent was obtained from parents or legal guardians, and verbal assent was secured from all students. Participants were informed that they could withdraw from the study at any time without academic penalty or negative consequences.

Confidentiality and data privacy were strictly maintained throughout the research process. All collected data—including pre-test, post-test, and delayed post-test scores—were anonymized through unique identification codes, and no personal identifiers were recorded in the dataset. Student performance data retrieved from the Kahoot platform (e.g., accuracy, participation, and leaderboard ranking) were used solely for research purposes and were stored on password-protected devices accessible only to the research team. No audio, video, or identifiable images of students were collected. Overall, the study received approval from Kharazmi University, Tehran, Iran, and was reviewed for both ethical and scientific aspects.

Results

A total of 277 sixth-grade students were assessed for eligibility to participate in the study. Following screening and consent, all participants were assigned to one of three groups based on the instructional method and reward type. The control group (n=95) engaged in traditional online learning through a social network platform, while the first experimental group (n=90) participated in Kahoot-based learning with intangible rewards such as points and leaderboard rankings. The second experimental group (n=92) also used Kahoot but received a combination of tangible and intangible rewards. All groups completed the pre-test, participated in six instructional sessions over six weeks, and took part in the post-test assessment. Data from all participants were included in the final analysis, as there were no reported cases of attrition or incomplete responses. Figure 4 presents the CONSORT flowchart illustrating the participant allocation, intervention, and analysis process.

Table 1 summarizes mathematics scores across three stages—pre-test, post-test, and retention—for each group. The control group showed minimal improvement and lower retention (M=11.86), while the intangible reward group had moderate gains but reduced retention (M=12.27).

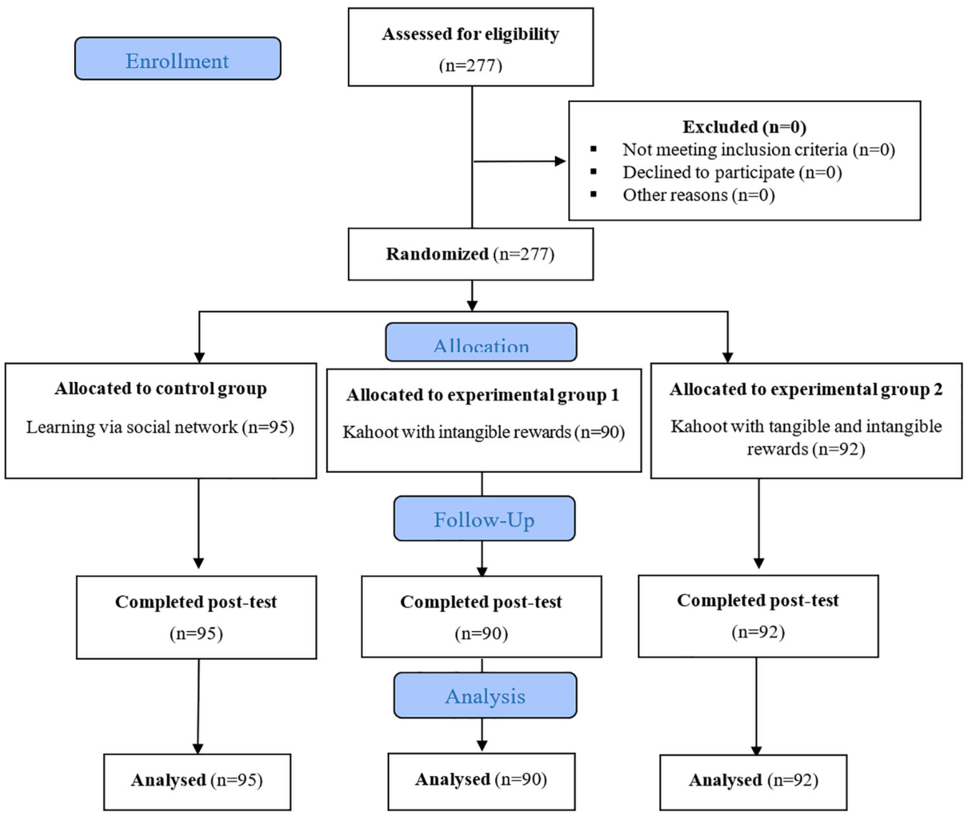


Figure 4: The participants' recruitment flow diagram

Table 1: Descriptive statistics of mathematics scores and mean gain compared to baseline

Variable	Group	Stage	Frequency	Mean±SD	Mean gain
Mathematics	Control	Pre test	95	13.00±4.16	-
		Post test	95	13.14±4.11	+0.14
		Retention	95	11.86±4.65	−1.14
	Intangible rewards	Pre test	90	14.92±3.53	-
		Post test	90	15.85±4.00	+0.93
		Retention	95	12.27±4.93	−2.65
	Tangible + Intangible rewards	Pre test	92	11.61±4.67	-
		Post test	92	17.03±3.05	+5.42
		Retention	95	16.39±2.79	+4.78

SD: Standard Deviation

In contrast, the group receiving both tangible and intangible rewards demonstrated the highest post-test (M=17.03) and retention scores (M=16.39), despite starting with the lowest baseline. These results suggest that combining reward types significantly enhances both immediate learning and long-term retention. As shown in Table 1, the group receiving both tangible and intangible rewards demonstrated the highest mean gain from pre-test to post-test (+5.42) and retained most of their learning (+4.78), outperforming the other groups.

Figure 5 illustrates the change in mathematics scores from pre-test to post-test across the three groups. The tangible + intangible rewards group showed the most substantial improvement, rising from the lowest baseline to the highest post-test score. This visual trend aligns with the descriptive statistics presented in Table 1.

The descriptive statistics presented above provide an initial overview of students' performance across the three groups and time points. While these figures suggest notable differences in learning gains—particularly in the group receiving both tangible and intangible rewards—further statistical analysis is required to determine whether these differences are statistically significant. To address this, ANCOVA was performed to compare post-test scores across groups while controlling for baseline performance.

Due to violations of ANCOVA assumptions—including unequal error variances (Levene's test: F=25.94, P<0.001) and non-homogeneous regression slopes—a GLM with robust estimators was employed. The model included pre-test scores as a covariate and used a normal distribution with an identity link function.

As shown in Table 2, both reward type and pre-test scores had statistically significant effects on post-test performance. The positive coefficients for the reward groups indicate that both interventions significantly improved post-test performance compared to the control group. Specifically, students who received intangible rewards scored on average 1.22 points higher than those in the control group, with this difference being highly significant (P<0.001). Moreover, students in the group receiving both tangible and intangible rewards scored an average of 4.97 points higher than the control group, also with strong statistical significance (P<0.001). Additionally, the pre-test scores had a significant positive influence (B=0.777, P<0.001), indicating that students with higher baseline scores tended to achieve better results on the post-test.

Pairwise comparisons of estimated marginal means revealed statistically significant differences between all three groups. As shown in Table 3, the tangible +

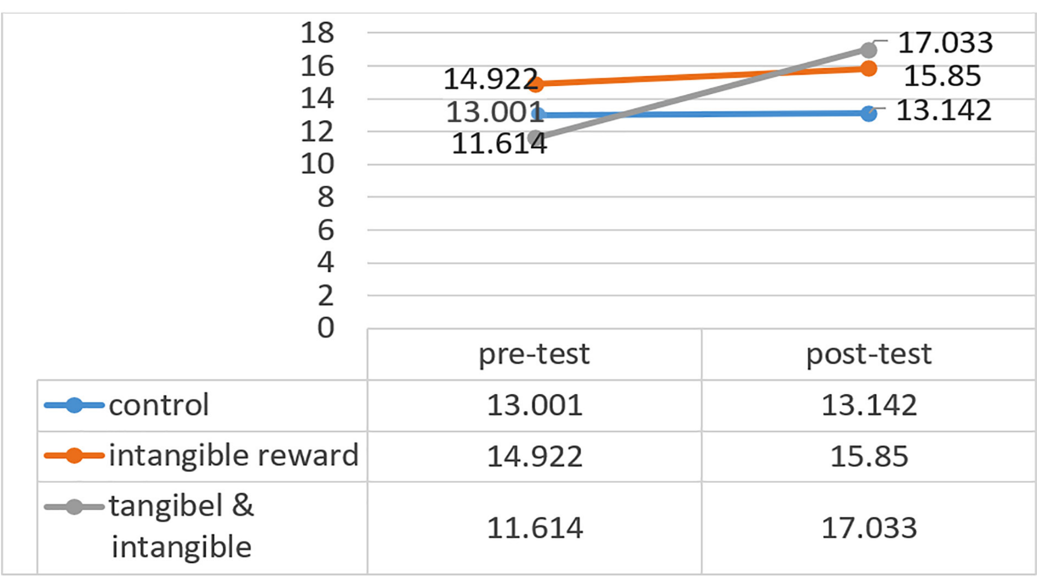


Figure 5: Comparison of pre-test and post-test scores by group

Table 2: Generalized linear model parameter estimates with robust standard errors

Parameter Estimates						
Parameter	Beta	Standard Error	95% Wald Confidence Interval		Hypothesis Test	
			Lower	Upper	Wald Chi-Square	P-value
Tangible + Intangible	4.97	0.31	4.36	5.58	254.85	<0.001
Intangible Reward	1.22	0.25	0.72	1.71	23.61	<0.001
Control	Reference Category					
Pretest	0.77	0.04	0.69	0.87	291.84	<0.001

Table 3: Pairwise comparisons of estimated marginal means

Pairwise Comparisons				
Group (I)	Group (II)	Mean Difference (Mean I - Mean II)	Standard Error	P-value
Tangible + Intangible	Intangible	3.75	0.36	<0.001
	Control	4.97	0.31	<0.001
Intangible	Tangible + Intangible	-3.75	0.36	<0.001
	Control	1.21	0.25	<0.001
Control	Tangible + Intangible	-4.97	0.31	<0.001
	Intangible	-1.21	0.25	<0.001

intangible reward group outperformed both the intangible-only and control groups, while the intangible reward group also showed a significant advantage over the control group.

All mean differences were statistically significant (P<0.001). Specifically, the tangible plus intangible reward group scored on average 4.97 points higher than the control group and 3.75 points higher than the intangible-only group, while the intangible reward group scored 1.22 points higher than the control group. These findings confirm that both reward strategies enhanced learning outcomes, with the combined tangible and intangible rewards producing the greatest effect.

In this study, learning outcomes were defined as students' capability to solve mathematics problems appropriate for their grade level, apply conceptual knowledge, and exhibit procedural skills. These skills were evaluated using a researcher-created test comprising both short-answer and extended-response questions. The notable differences observed in post-test and retention scores among the groups demonstrate clear advancements in these cognitive areas. The enhanced performance of the group receiving both tangible and intangible rewards suggests that integrating multiple types of incentives in a gamified setting can effectively boost essential math skills

Discussion

This study investigated the comparative effects of tangible and intangible rewards within a gamified learning environment using Kahoot for mathematics education among sixth-grade students. The findings demonstrate that both types of rewards significantly enhanced student motivation, engagement, and learning outcomes compared to traditional online instruction, with the combination of tangible and intangible rewards yielding the highest gains in both immediate performance and retention. These results contribute to a growing body of literature supporting the use of gamification and reward systems to enhance educational outcomes.

Previous research has consistently demonstrated that gamified platforms such as Kahoot increase student engagement, enjoyment, and learning outcomes (14, 21). However, the literature presents mixed conclusions regarding the effectiveness of different reward types. For instance, Bai and colleges (18) found that tangible rewards increased participation but not necessarily academic performance, while Xiao and Hew (19) reported that intangible rewards may be more effective for enhancing intrinsic motivation. Arora and his colleagues reported limited impact of non-monetary recognition on student performance, suggesting that symbolic rewards alone may not be sufficient to significantly enhance academic outcomes (22). These discrepancies may stem from differences in reward context, delivery method, and integration with learning platforms. The current study adds nuance to this debate by showing that the combination of both tangible and intangible rewards, especially when integrated with a leaderboard, maximizes learning gains and retention. Recent research supports the idea that combining tangible and intangible rewards creates a more robust motivational framework for students. For instance, a study by Singh and colleagues highlights that gamified platforms like Kahoot significantly boost student engagement and learning outcomes when rewards are diversified and integrated with competitive elements such as leaderboards (23). Similarly, Maraza-Quispe and colleagues emphasize that gamification enhances cognitive skills and motivation, but the effectiveness of reward types depends on their contextual application within the learning environment (24). Furthermore, Park and colleagues demonstrate that leaderboards not only increase motivation but also foster social recognition, which strengthens intrinsic motivation, especially when coupled with diverse reward systems. These findings align with the present study, suggesting that the synergy between tangible incentives and social/competitive recognition can yield superior educational results compared to isolated reward mechanisms (25).

The leaderboard mechanism appears to play a crucial role in amplifying the effects of rewards. By providing visible feedback and fostering a sense of competition, leaderboards encourage students to strive for higher performance, which is supported by gamification theory (21). The competitive environment created by leaderboards not only motivates students to achieve better results but also promotes social recognition, which can further enhance motivation and engagement. However, this approach may also introduce equity concerns, as students with lower baseline skills may feel less motivated if they rarely reach top ranks. Future research should explore balanced reward systems that recognize diverse forms of progress, not just top performance (26).

An additional consideration in interpreting the findings relates to the psychological mechanisms underlying reward-based learning. Tangible rewards may primarily stimulate extrinsic motivation, encouraging students to participate for immediate benefits, while intangible rewards such as points and leaderboard rankings foster intrinsic motivation by reinforcing feelings of competence, autonomy, and social recognition (27). The interplay between these motivational pathways is critical, as sustained learning outcomes often depend on the gradual internalization of extrinsic incentives into intrinsic drivers of engagement (28). Moreover, gamified environments like Kahoot provide opportunities for repeated practice, immediate feedback, and peer comparison, which together create a dynamic cycle of reinforcement that extends beyond short-term performance gains. Importantly, the integration of diverse reward types may also support equity in classrooms by appealing to students with different motivational profiles—some responding more strongly to symbolic recognition, others to material reinforcement (27). This suggests that hybrid reward systems can accommodate heterogeneous learner needs, thereby promoting inclusivity. From a pedagogical perspective, the challenge lies in designing reward structures that balance competition with collaboration, ensuring that leaderboards motivate without discouraging lower-performing students. Future research should therefore examine how reward diversity interacts with classroom climate, teacher facilitation, and cultural expectations to shape both cognitive and socio-emotional outcomes in mathematics education.

The findings of this study have important practical implications for educators and instructional designers. The integration of both tangible and intangible rewards in a competitive, interactive platform appears to be a powerful strategy for enhancing motivation and achievement in digital learning environments. Tangible rewards, such as notebooks, pencil cases, and books, provide immediate, concrete incentives that can boost extrinsic motivation. Intangible rewards, such as points and leaderboard rankings, foster a sense of achievement and social recognition, which can enhance intrinsic motivation. The combination of these reward types creates a multifaceted motivational environment that addresses both extrinsic and intrinsic motivators, leading to higher levels of engagement and better learning outcomes. The use of leaderboards can further enhance motivation by providing visible feedback and fostering a sense of competition. However, it is important to design reward systems that are equitable and inclusive, recognizing diverse forms of progress and ensuring that all students have opportunities to succeed.

Limitations and Suggestions

The intervention in this study was delivered remotely because of the COVID-19 pandemic, which might have influenced students' participation and accessibility. The study was limited to a six-week period, so the long-term sustainability of reward effects remains unclear. Additionally, gender and cultural differences were not analyzed, which could influence how students respond to gamified learning environments. These limitations highlight the need for further research to validate the findings in different contexts and to explore the long-term effects of reward systems on student motivation and achievement.

Future studies should replicate this design in face-to-face settings, extend the intervention period, and examine the impact of gender and cultural factors. Investigating different types of rewards, such as social recognition or group incentives, could also provide deeper insights into effective motivational strategies. Furthermore, longitudinal research is needed to assess whether the observed gains persist over time and whether novelty-driven engagement translates into lasting learning outcomes.

Conclusion

This study contributes to the ongoing debate on educational rewards by demonstrating that the type and delivery of rewards matter, and that gamified structures like leaderboards can significantly shape their effectiveness. The integration of both tangible and intangible rewards in a competitive, interactive platform appears to be a powerful strategy for enhancing motivation and achievement in digital learning environments. Future research should continue to explore the long-term effects of reward systems and their impact on student motivation and achievement in different contexts.

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Authors' Contribution

FJ drafted the initial manuscript and collected the data. YM conceptualized and designed the study, as well as contributed critical revisions and editing. MJ performed the data analysis. All authors reviewed and approved the final version of the manuscript.

Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

Ethical Considerations

In this research, participants were first informed about the objectives of the study and were asked to provide their consent to participate. They were assured that their participation was voluntary and that they could withdraw from the study at any time without any consequences. The data collected during the research was treated as confidential and was used solely for academic purposes. Upon completion of the study, participants were given access to the training methods used by other groups as part of the transparency process. This research was approved by Kharazmi University in session 238 of the Faculty Council on 06/02/1400 (April 24, 2021), and was reviewed for both ethical and scientific aspects.

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Availability of Data and Materials

The datasets generated or analyzed during the current study are available from the corresponding author upon reasonable request.

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