Gamification as a Strategy to Improve Math Performance in Seventh Grade: A Quasi-experimental Study.

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Abstract

The learning of fractions remains one of the main challenges in mathematics for students in basic education, due to its abstract nature and limited connection to everyday situations [1]. These difficulties are exacerbated by the use of traditional methodologies, which restrict active participation and student motivation [2]. In response to this issue, the present study aimed to evaluate the impact of a gamification strategy on the learning of operations with fractions in seventh-grade students, based on game dynamics, rewards, and digital interaction [5]. A quasi-experimental design with a non-equivalent control group was adopted, consisting of 40 students divided into two intact groups. The experimental group participated in gamified sessions, while the control group continued with traditional instruction. Diagnostic (pre-test) and final (post-test) assessments were applied to measure academic performance. Non-parametric tests were used due to the non-normal distribution of the data, which justifies the use of techniques such as the Wilcoxon and Mann-Whitney tests [3][23]. The results showed that the experimental group significantly improved its performance, reaching a post-test mean of 4.46 compared to 1.34 in the control group. Furthermore, greater homogeneity in results and a qualitative increase in student participation and engagement were observed. These findings support both the theoretical foundations of gamification [5], and previous studies reporting improvements in mathematical learning through playful strategies [13]. It is concluded that gamification is an effective pedagogical strategy to promote meaningful learning in the mathematics classroom.

Keywords — Gamification, Education, Pedagogical strategies, Learning impact, Mathematics teaching.

I- Introduction

Teaching mathematics in secondary education has historically presented a significant challenge, particularly due to the negative perception many students have of this subject. Mathematics is often considered an abstract, difficult subject with no connection to everyday life [16]. This view is intensified when addressing topics such as fractions, which require specific cognitive skills, including proportional reasoning, abstract thinking, and the understanding of multiple symbolic representations [24][25]. These difficulties lead to high levels of frustration, demotivation, and low academic performance, creating a gap between what is taught and what students actually learn [8].

Much of this problem lies in the use of traditional methodologies focused on memorization and rote learning, which limit the student's active participation and emotional connection with mathematical knowledge [10][22]. In this context, the search for innovative pedagogical strategies that respond to the characteristics, interests, and needs of the 21st-century student, promoting more dynamic, contextualized, and meaningful learning, becomes especially relevant [15].

One of the emerging methodologies with the greatest potential in this field is gamification, understood as the incorporation of game elements (points, levels, badges, immediate feedback, among others) into non-game environments such as education [11]. This strategy has been shown to generate more engaging learning environments by enhancing intrinsic motivation, commitment, and student autonomy [6]. Furthermore, recent research demonstrates that gamification promotes the understanding of complex mathematical concepts, including fractions, by providing more active, visual, and collaborative learning experiences [25][10]. By incorporating game mechanics such as rewards, levels, and challenges, this strategy has the potential to increase student motivation and engagement in educational contexts [26].

In the specific field of mathematics, studies have indicated that gamification can improve attitudes toward the subject, increase class participation, and significantly contribute to academic performance [22]. For example, through interactive digital platforms or structured games, students develop problem-solving, logical reasoning, and critical thinking skills, which are essential for consolidating their understanding of fractions [24][11]. However, the current educational context recognizes that, in addition to these cognitive skills, students' social attitudes and competencies, such as collaboration, communication, and a willingness to work in teams, are also fundamental to learning mathematics [18].

Low performance in mathematics remains a persistent challenge in basic education, especially in topics such as fractions, which require abstract reasoning skills and proportional understanding. Learning difficulties have been associated with traditional methodologies focused on memorization and repetition, where students assume a passive role instead of becoming active agents in their own learning process [1][2].

Teaching fractions involves not only mastering algorithms but also understanding fundamental concepts with applications in daily life. However, these skills are often not developed meaningfully due to a lack of motivation, weak connections to the student's context, and limited use of innovative tools in the classroom [13]. Given this situation, it is crucial to rethink pedagogical strategies to strengthen meaningful learning, student engagement, and interest in mathematics.

Recent literature has identified that, to improve the learning of complex content such as fractions, it is necessary to integrate motivational and social factors that stimulate active student participation [18][21]. In this sense, gamification has become established as an effective methodology for transforming traditional teaching by incorporating elements and mechanics of games—such as missions, levels, rewards, and immediate feedback—with the purpose of improving performance, motivation, and attitude toward learning [5][17].

Previous studies have shown that gamification not only increases intrinsic motivation but also facilitates the acquisition of mathematical concepts, fosters collaboration, and improves the learning environment [20][7]. However, many gamified strategies focus exclusively on digital resources, neglecting social aspects such as peer cooperation, collaborative work, and the collective construction of knowledge.

Since learning fractions involves not only cognitive skills but also attitudes and social skills, it is necessary to design gamified strategies that promote interaction among students, mathematical dialogue, and collaborative problem-solving. Despite advances in the use of educational technologies, gaps remain in the design of gamified approaches focused on non-technical competencies such as cooperation, perseverance, and self-efficacy.

Considering the above, this article presents an empirical research study with a quasi-experimental design, conducted in a basic education academic setting. The objective of this study was to analyze the impact of a gamified strategy on the learning of operations with fractions in seventh-grade students at the Adventist School of Apartadó, located in the department of Antioquia, Colombia, comparing its effects on academic performance and student participation with a control group that received traditional instruction.

The results show a significant improvement in the performance of the experimental group, as well as an increase in motivation and active engagement during the teaching and learning process. These findings reaffirm the potential of gamification as a pedagogical tool to improve the quality of mathematics education and to foster a more dynamic, inclusive, and participatory school environment.

This document is structured as follows: Section 1 describes the elements of the gamified strategy and the quasi-experimental design. Section 2 presents the results obtained. Section 3 contains the discussion of these results, and Section 4 presents the conclusions and potential avenues for future research.

II-METHODOLOGY

A. *Type of research*

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This study was conducted using a quasi-experimental design with a non-equivalent control group, which allows for establishing causal relationships in situations where random assignment of participants is not feasible [12]. This approach is widely used in school settings, where groups are already formed, and it is necessary to evaluate the impact of an educational intervention under real-world conditions [4].

The main objective of the quasi-experiment was to evaluate the influence of a gamification strategy on academic performance and motivation in learning operations with fractions among seventh-grade students. The strategy was applied only to the experimental group, while the control group continued with traditional instruction.

The general hypothesis of the study is shown in equation (1).

$$H1_0\colon \theta = \theta_0 \qquad (1)$$
$$H1_1\colon \theta > \theta_0$$

Where, $H1_0$null hypothesis, there is no difference in the median between the PreTest and the PostTest , i.e., there was no significant improvement ($\theta = \theta_0$), $H1_1$alternative hypothesis, research hypothesis, there is a significant difference between the PreTest and the PostTest of the experimental group and the control group ($\theta > \theta_0$).

gamified intervention , comprised of playful, digital, and participatory activities. The dependent variable was academic performance, measured through diagnostic tests (pretest) and outcome tests (posttest).

The quasi-experiment was implemented in a real school setting, with two groups of seventh-grade students from a private educational institution. Specific details of the population and application conditions are described in the following sections.

B. *Population and sample.*

The study population consisted of seventh-grade students from the Adventist School of Apartadó, located in the department of Antioquia, Colombia. This private educational institution offers basic and secondary education based on Christian-Adventist principles. A sample of 40 students was selected, divided equally into two groups of 20 students each. The sample was selected using purposive non-probability sampling, meaning that participants were not chosen randomly, but rather based on criteria previously defined by the researcher. This sampling strategy is commonly used in educational research, especially when it is necessary to control for certain participant characteristics to ensure the validity of the intervention [21]. In this case, it was ensured that the students in both groups had similar academic, demographic, and contextual conditions before the intervention began. Variables such as gender, prior academic performance in mathematics, access to technological devices, and willingness to use digital resources were taken into account.

The experimental group was exposed to a pedagogical intervention based on gamification strategies, which included the use of interactive digital platforms, educational games, reward systems, missions, scoreboards, and other dynamics typical of active learning. These strategies were designed to strengthen student engagement, participation, and motivation in the process of learning operations with fractions.

The control group, on the other hand, continued with content development using traditional methodologies, focusing on lectures, solving exercises on the board, and conventional notebook activities, without incorporating any gamified or technological elements. This allowed for a direct comparison of the effects of both methodologies on student performance and motivation. Furthermore, the sample consisted of students with diverse levels of mathematical performance, ranging from low to high, in order to evaluate the impact of gamification on different learning profiles and determine whether this strategy is more effective at certain levels of academic competence.

The careful delimitation of the sample and the controlled implementation of the intervention provide the necessary conditions to rigorously evaluate the impact of gamification on the learning of fractions, thus providing useful empirical evidence for future pedagogical applications.

Regarding ethical considerations, the study was conducted with the formal authorization of the educational institution and with the informed consent of the students' parents and guardians. The anonymity and confidentiality of the collected information were guaranteed, in accordance with the ethical principles established for educational research with minors.

C. Data collection techniques and instruments.

To rigorously evaluate the impact of gamification on the learning of operations with fractions in seventh-grade students, quantitative instruments were used that allowed for the objective measurement of changes in academic performance.

- *Academic Tests (Pretest and Posttest)*

Two standardized tests were administered: a diagnostic test (pretest) before the intervention, and a final test (posttest) at the end of the process. Both were designed based on previously validated models, aligned with the national curriculum standards for seventh grade, and included:

- Multiple choice items with a single answer.
- Mathematical problem-solving exercises.
- Contextualized problems that involved understanding homogeneous and heterogeneous fractions, as well as basic operations (addition, subtraction, multiplication and division).

These tests allowed for quantitative comparisons between the performance levels of the experimental group and the control group, and between pre- and post-intervention measurements [21].

The design of the instruments was based on previous research that supports the validity of the pretest- posttest approach for measuring the effect of educational interventions. In particular, the study by Karamert , Ö., & Kuyumcu Vardar , A [14]. showed that the implementation of gamification strategies has a positive impact on both academic performance and students' attitudes towards mathematics.

The data were analyzed using the statistical software R (version 4.4.0) [19], employing descriptive and inferential statistics. Prior to analysis, the Shapiro-Wilk normality test was applied to the pretest and posttest scores in both groups. Since the results indicated that the data did not follow a normal distribution, non-parametric statistical tests were used.

Specifically, the Wilcoxon test was applied to compare the pretest and posttest results within each group, and the Mann-Whitney U test or Wilcoxon Rank-Sum test was used to compare the posttest results between the control group and the experimental group.

- *Phases of the intervention process*

The educational intervention was developed in three sequential phases that allowed for the planning, execution, and evaluation of the impact of the gamified strategy with methodological rigor:

Phase 1: Introduction

During this initial stage, students were made aware of the research purpose and the role of gamification as a pedagogical strategy. The rules of the gamified environment , participation dynamics, and the tools to be used during the intervention were also explained. As part of the initial assessment, a diagnostic test (pretest) was administered to establish a baseline of prior knowledge of fractions and to characterize the academic performance of both groups before the intervention.

Phase 2: Implementation

This phase formed the core of the quasi-experiment and was conducted over three consecutive weeks, according to the work schedule. During this period, gamified activities aligned with the seventh-grade mathematics curriculum were carried out. The sessions included:

- Presentation of topics using visual resources and videos.
- Spaces for conceptualization and collective reflection.
- Gamified activities were implemented using tools such as Quizizz , Canva , and Math Jeopardy. These activities incorporated mechanics such as challenges, levels, rewards, experience points, and badges, following the recommendations of Elles Ardila and Gutiérrez [7]. Their integration allowed for the creation of an active and participatory learning environment, aligned with the needs of the 21st-century student.

The planning of these sessions was organized following a repetitive and progressive structure, as detailed in the Gamified Educational Intervention Schedule (see Table 1).

Phase 3: Evaluation

post -test was administered to measure improvements in academic performance following the intervention. Additionally, participant observation records were compiled, allowing for a quantitative and qualitative analysis of the gamification's impact. This comprehensive analysis served to assess the intervention's pedagogical effectiveness, particularly regarding the development of mathematical skills and the change in attitudes toward learning fractions.

TABLE 1. TIMELINE OF THE GAMIFIED EDUCATIONAL INTERVENTION IN THE TEACHING OF FRACTIONS

Topic to be discussed	**Date**	**Application time**
Heterogeneous and homogeneous fractions	Week 1	4 (hours)
		30-minute video on the topic
		40 minutes of reflection on the topic
		40 minutes conceptualization
		2 hours Jepardy strategy
		10 minutes Quizizz
Addition and subtraction, unlike and unlike fractions	Week 2	4 (hours)
		30-minute video on the topic
		40 minutes of reflection on the topic
		40 minutes conceptualization

		2 hours Jepardy strategy
		10 minutes Quizizz
Multiplication and division of heterogeneous and homogeneous fractions	Week 3	4 (hours)
		30-minute video on the topic
		40 minutes of reflection on the topic
		40 minutes conceptualization
		2 hours Jepardy strategy
		10 minutes Quizizz
Assessment	Week 4	1 (hours)
		5 minutes of reflection
		30-minute evaluation
		20 minutes reward delivery

III- RESULTS

This quasi-experimental study aimed to evaluate the impact of a gamified intervention on the learning of operations with fractions in seventh-grade students at the Adventist School of Apartadó, located in the department of Antioquia, Colombia. To this end, two intact groups were used: an experimental group, which participated in gamified sessions , and a control group, which continued its learning through traditional methodologies.

Both groups were assessed using a diagnostic test (pretest) before the intervention and a final test (posttest) at its conclusion. The tests were scored on a scale of 1 to 5, with 1 being the lowest score and 5 the highest, in accordance with the institution's academic evaluation criteria.

below presents the results obtained by the students in both groups, with their respective scores in the pretest and posttest , which allows us to observe the changes in academic performance after the pedagogical intervention.

TABLE IRESULTS OF THE CONTROL AND EXPERIMENTAL GROUPS

Number of Students	**Groups**			
	Control		**Experimental**	
	Pretest	**PostTest**	**Pretest**	**PostTest**
1	1.8	1	2.2	4.6
2	2.6	1	1.8	4.6
3	2.2	1	1.8	4.6
4	1.4	1	1	4.6
5	1.4	1	1.4	4.6
6	1.4	1.4	1	4.6
7	1.4	1.4	1	4.2
8	1.8	1.4	1	4.6
9	1.4	1.8	1	4.6
10	1	1.4	1.4	4.2
11	1	1.4	1.4	4.6
12	1	1.4	1	4.2

13	1	1.4	1	4.2
14	1.4	1	1.4	4.6
15	1	1.4	1.8	4.6
16	1	1.8	1.4	4.6
17	1	2.6	1.4	4.6
18	1	1.4	1.4	4.2
19	1	1	1	3.8
20	1	1	1.4	4.6

Based on the data presented in Table II, it can be observed that both groups began with low and relatively similar scores on the pretest. In the control group, the posttest scores showed minimal or no improvement; in some cases, there was even a decrease compared to the pretest. In contrast, the experimental group showed a notable increase in their scores, with most students achieving scores equal to or higher than 4.2their pretest scores, suggesting a significant improvement in their academic performance after the implementation of the gamified strategy. This difference suggests a positive impact of the intervention on learning operations with fractions.

This qualitative analysis is complemented by the quantitative results presented in Table III. In both groups, the pretest average was [value missing] 1.34, confirming similar initial conditions. However, while the control group maintained its average in the posttest (1.34 ± 0.40), the experimental group reached an average of [value missing] 4.46 ± 0.23, demonstrating a substantial and consistent improvement in their academic performance. This difference reinforces the effectiveness of the gamified intervention, not only due to the overall increase in performance but also because of the reduced variability among students.

TABLE III. AVERAGES AND STANDARD DEVIATIONS OF THE RESULTS IN THE PRETEST AND POSTTEST

Cluster	**Pretest (Mean ± SD)**	**Posttest (Mean ± SD)**
Control	1.34 ± 0.45	1.34 ± 0.40
Experimental	1.34 ± 0.35	4.46 ± 0.23

Note: SD = Standard Deviation

The results obtained in the pretest and posttest of the experimental and control groups were subjected to a normality test to determine whether the variables followed a normal distribution. This verification is necessary because, to apply the Student's t-test, the data must meet the assumption of normality.

To this end, the following statistical hypotheses were proposed for equation 2:

$$H2_0 = Data\ follow\ normal\ distribution$$

(2)

$$H2_1 = Data\ don't\ follow\ normal\ distribution$$

Where $H2_0 = P \geq 0.05$represents that the variable follows a normal distribution and $H2_1 = P < 0.05$represents that the variable does not follow a normal distribution, then, in Table II, the results of the normality test are presented applying the Shapiro-Wilk test, suitable for samples of less than 50 students.

TABLE III. RESULTS OF THE NORMALITY TEST (SHAPIRO-WILK)

Groups	
Control	**Experimental**

Variable	Pretest	PostTest	Pretest	PostTest
W(statistic)	0.75947	0.75066	0.82589	0.63204
P- value	0.000228	0.000173	0.00215	$6{,}442\ e\ {-6}$
Interpretation	The data do not follow a normal distribution.			

As shown in Table IV, all p-values are less than 0.05, indicating that none of the analyzed variables follow a normal distribution. Consequently, non-parametric statistical tests were chosen for the analysis of the results, specifically the Wilcoxon test to compare the pre-test and post-test within each group and the Mann-Whitney U test for the comparison between groups.

To evaluate the impact of the gamification strategy on mathematics learning, non-parametric statistical tests were applied, given that the data did not meet the normality assumptions required for parametric tests. First, an intra-group comparison (within the same group) was performed between the pre-test and post-test using the Wilcoxon signed-rank test for related samples. The results are presented in Table V.

TABLE VWILCOXON TEST TO COMPARE PRETEST VS POSTTEST RESULTS WITHIN THE SAME GROUP

Groups		
Statistical	Control (PreTest vs PostTest)	Experimental (PreTest vs PostTest)
	Worth	Worth
V	67.5	0
P- value	1	0.00008788

To evaluate the difference in academic performance of these groups, the hypotheses of equation (3) were formulated:

$$H3_0: \theta = \theta_0$$

(3)

$$H3_1: \theta > \theta_0$$

Null hypothesis ($H3_0$): There is no difference in the median between the PreTest and the PostTest, that is, there was no significant improvement ($\theta = \theta_0$).

Alternative hypothesis ($H3_1$), research hypothesis: There is a significant difference between the PreTest and PostTest of the experimental group and the control group ($\theta > \theta_0$).

In the control group, the p-value was 1.000, greater than the significance level of 0.05. This leads to the acceptance of the null hypothesis, indicating that there were no statistically significant changes between the pretest and posttest results . Therefore, it is concluded that the academic performance of the control group did not improve after the evaluation period.

In contrast, the experimental group yielded a value $p$of 0.00008788, which is considerably lower than 0.05. In this case, the null hypothesis is rejected and the alternative hypothesis is accepted, concluding that there was a statistically significant improvement in the academic performance of the students in the experimental group. It is worth noting that the statistic $V = 0$suggests that all or almost all students improved their results in the post-test after the gamified intervention .

Next, an inter-group comparison of the post -test results between the control and experimental groups was performed using the Wilcoxon Rank-Sum test (also known as the Mann-Whitney U test). The results are summarized in Table VI.

TABLE VIWILCOXON RANK-SUM TEST RESULTS OF THE POST-TEST OF THE CONTROL GROUP VS. EXPERIMENTAL GROUP.

Groups

Statistical	Control vs. Experimental (PostTest)
	Worth
W	0
P- value	2.443 e^{-8}

post-test scores in the experimental group were higher than those in the control group. Additionally, the p-value = 2.443e^{-8} (< 0.05) demonstrates a significant difference between the groups, confirming that the gamification strategy had a positive effect on the academic performance of the experimental group. These findings are consistent with those reported by Malvasi and Recio-Moreno [17], who found that gamification improves both student learning and motivation in mathematics.

These quantitative results are complemented by the visual representation shown in Fig. 1, which illustrates the evolution of the mean academic performance at the evaluation times (pretest and posttest) for both groups.

To provide an overview of the statistical analyses performed, a summary table summarizing the results of the inferential comparisons is presented below. This table includes the statistical values, significance levels (p-values), and corresponding interpretations for each of the tests applied.

TABLE VII. SUMMARY OF THE INFERENTIAL STATISTICAL ANALYSIS

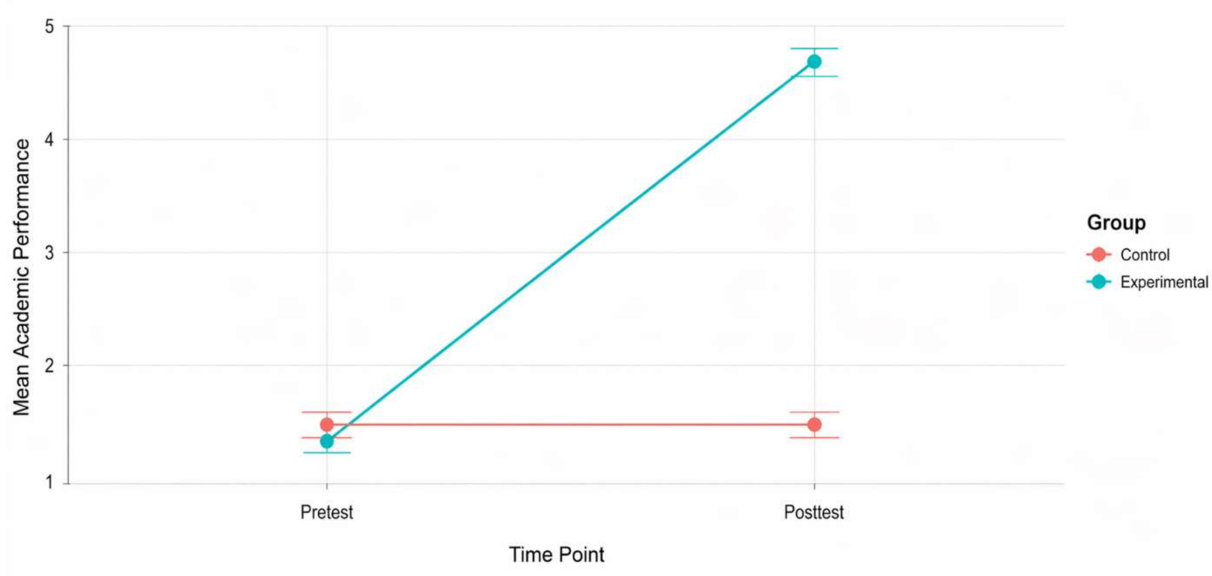
Comparison	Test used	Statistical	p-value	Interpretation
Control: Pretest vs. Posttest	Wilcoxon	V = 67.5	1,000	Not significant
Experimental: Pretest vs. Posttest	Wilcoxon	V = 0	0.00008788	Significant improvement
Control vs. Experimental (Posttest)	Mann–Whitney (Rank-Sum)	W = 0	2.443e^{-8}	Significant difference between groups

As shown in Table VII, the experimental group demonstrated a statistically significant improvement in academic performance between the pretest and posttest (p-value $p < 0.001$), while the control group showed no significant differences. Furthermore, the posttest results revealed a significant difference between the two groups, with a p-value less than 0.05 0.0000001, indicating that the experimental group consistently outperformed the others. These results reinforce the effectiveness of the gamification strategy compared to the traditional methodology.

Figure 1 clearly shows that the control group did not show significant changes between the pretest and posttest , remaining at low performance levels, with average scores close to 1. This indicates that, without intervention, the students maintained low academic performance.

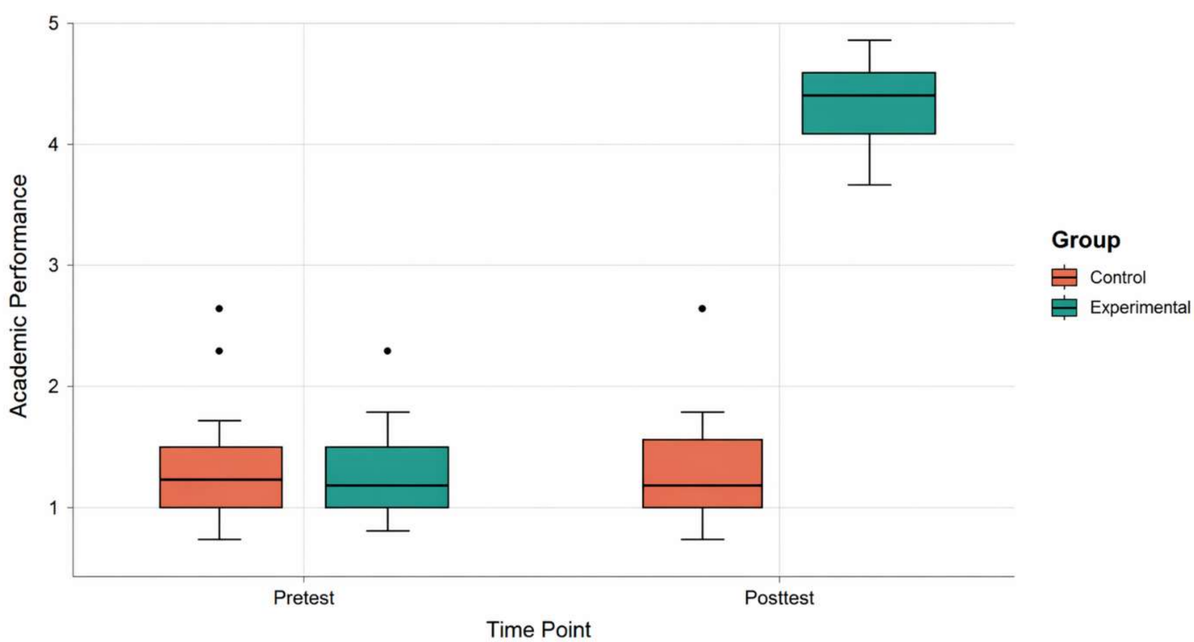
In contrast, the experimental group showed a marked improvement in their academic performance, rising from an average close to 1 in the pretest to an average above 4 in the posttest . This difference is consistent with the statistical results described above and demonstrates that the gamification strategy had a positive and significant effect on student learning.

This improvement can be partly explained by the motivating and interactive nature of the implemented strategy. According to Olmedo-Flores, DE, Gordon-Merizalde, GJ, Jara-Zarria, HM, Chuqui- Shañay , ME, Lema - Coordonez , SX, & Palaguaray-Guagrilla , D. A [18], this finding aligns with theories of intrinsic motivation and active learning, which indicate that the use of active methodologies such as gamification can improve the understanding of complex content by engaging students dynamically and meaningfully in their learning process.



The bars represent the standard error. A significant improvement is observed in the experimental group between pretest and posttest , while the control group maintains stable performance.

Fig. 1. Mean academic performance in the pretest and posttest of the control and experimental groups.



Outliers and score concentrations are displayed for each evaluation time.

Fig. 2. Distribution of academic performance in the control and experimental groups, before and after the intervention.

Figure 2 presents a boxplot that illustrates the data dispersion. It shows that the experimental group not only improved on average but also reduced the dispersion of scores in the post-test , reflecting more homogeneous learning. In contrast, the control group maintained low scores and slightly greater variability, with no notable improvements.

In summary, the quantitative and graphical results allow us to conclude that the gamification-based intervention had a positive and significant impact on the academic performance of the students in the experimental group, both in terms of average improvement and homogeneity of results.

IV- DISCUSSION

The findings of this research confirm the hypothesis: gamification, as an educational strategy, has a positive and significant impact on the learning of operations with fractions in seventh-grade students. Statistical analysis of the pre-test and post-test in the experimental group, using the Wilcoxon signed-rank test, showed a highly significant improvement in academic performance. Conversely, in the control group, which continued with traditional teaching methods, no statistically relevant differences were observed between the initial and final measurements. This result suggests that traditional strategies, in this specific context, did not generate notable progress in student learning.

The data analysis, performed using R software, yielded precise and visually understandable results, complemented by graphical representations that clearly illustrated the evolution of academic performance in both groups. Figure 1, for example, shows the marked increase in the average performance of the experimental group, while Figure 2 demonstrates not only an overall improvement but also a reduction in the variability of results among students, suggesting a more consistent improvement.

Beyond the quantitative results, it is important to highlight that the gamified tools applied generated a more dynamic, participatory, and student-centered learning environment. Although this research did not use a specific instrument to measure motivation, the qualitative observations made during the sessions showed an increase in engagement, interaction, and willingness to participate in the proposed activities. This perception aligns with the findings of Olmedo-Flores, DE, Gordon-Merizalde, GJ, Jara-Zarria, HM, Chuqui- Shañay , ME, Lema- Coordonez , SX, & Palaguaray-Guagrilla , D. A [18], who state that immediate feedback, symbolic rewards, and playful interaction strengthen intrinsic motivation and student involvement in the learning process.

The effectiveness of gamification observed in this study is consistent with previous research demonstrating its positive impact on learning abstract concepts, such as fractions [17]. In this particular case, the intervention not only increased individual scores but also enabled most students to achieve high levels of performance, exceeding the institutional threshold of expected academic achievement.

Although the results are encouraging and reflect clear improvements in academic performance, it is important to recognize that this study did not quantitatively assess affective variables such as motivation, enjoyment, or self-perception of learning. These aspects, while not directly measured, could have influenced the achievements observed in the experimental group, contributing an emotional and attitudinal dimension that potentially enhanced academic results.

On the other hand, the stable performance of the control group is particularly significant. While other studies commonly observe slight improvement due to repetition or familiarization with the instrument, this improvement was not evident in this case. This lack of change could be due to multiple factors: lack of interest, low motivation, a disconnect between the methods used and the students' needs, or even affective barriers associated with learning mathematics. As García-Sampedro and López-Pastor [9] point out, traditional methods focused on the transmission of content tend to limit the student's cognitive and emotional involvement, perpetuating existing difficulties.

This contrast between the two groups reinforces the importance of designing active, contextualized, and motivating educational experiences. The improvement observed in the experimental group cannot be explained solely by exposure to the content, since both groups had the same number of sessions. The difference clearly lies in the methodology: gamification offered a more meaningful, engaging, and collaborative experience.

In summary, this research provides empirical evidence supporting the use of gamification as an effective pedagogical strategy in the mathematics classroom, highlighting its potential to improve not only academic performance, but also student engagement and satisfaction.

V-CONCLUSIONS

The results obtained in this study allow us to conclude that implementing a gamification strategy has a positive and significant effect on the learning of operations with fractions in seventh-grade students. The experimental group showed a substantial improvement in their academic performance after the intervention, with notably higher and more consistent grades compared to the control group, which maintained a stable and low level of performance.

These findings reinforce the pedagogical value of active and innovative methodologies, such as gamification, which promote meaningful learning through participatory dynamics, constant feedback, and motivating elements. Unlike traditional approaches focused on content transmission, gamified strategies foster a more engaging and stimulating environment for students, increasing their involvement and conceptual understanding.

The empirical evidence obtained in this research supports the need for teachers to explore student-centered methodologies that respond to the challenges of the 21st century and the learning styles of new generations. Furthermore, the results suggest that the appropriate use of technological and playful resources can help close learning gaps in complex content such as fractions, particularly in contexts where traditional methodologies have proven insufficient.

However, this study has limitations that open avenues for future research. For example, while clear improvements in academic performance were observed, attitudinal and emotional aspects such as motivation, enjoyment, and perception of learning were not quantitatively assessed. It would be beneficial for future studies to incorporate validated instruments, such as Likert-type scales, structured interviews, or classroom journals, to allow for a more in-depth analysis of the affective and attitudinal impact of gamification.

Furthermore, it is recommended to broaden the sample size, replicate the study at other educational levels and in different areas of knowledge, and analyze the sustainability of the effects in the medium and long term. It would also be relevant to compare different types of gamification (digital, analog, collaborative, competitive) and their varying impact depending on the students' profiles.

In conclusion, this research contributes to the body of evidence on the transformative potential of gamification in the classroom. Its appropriate application can not only improve academic performance but also offer students a more active, meaningful, and emotionally positive learning experience. This, in turn, requires a shift in the teacher's role: from content transmitter to designer of educational experiences that foster the student's holistic development.

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