

Effects of Game-Based Learning in Teaching Mathematics for Elementary Pupils

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Abstract

This study determined the effects of game-based learning in teaching Mathematics for elementary pupils in selected public elementary schools in Baras District, Division of Rizal, during School Year 2025–2026. It specifically examined the perceived effects of game-based learning in terms of understanding mathematical concepts, computational skills, and problem-solving skills, as well as the challenges encountered by teachers in its implementation. The study employed a descriptive survey research design and utilized a researcher-made questionnaire-checklist as the primary instrument for data gathering. The respondents comprised the total population of 120 Mathematics teachers in Baras District, whose profiles were described according to age, sex, civil status, educational attainment, position title, length of service, and in-service trainings attended. Findings revealed that the majority of the respondents were 31–40 years old, female, married, Bachelor's degree holders, Teacher I, had 1–10 years of teaching experience, and had attended district-level in-service trainings. Game-based learning was perceived to always affect pupils' Mathematics learning in terms of understanding mathematical concepts, computational skills, and problem-solving skills. No significant differences were found in teachers' perceptions when grouped according to sex and civil status. However, significant differences were observed according to age in terms of understanding mathematical concepts; length of service in terms of understanding mathematical concepts and computational skills; and in-service trainings attended in terms of computational and problem-solving skills. Teachers moderately encountered challenges in implementing game-based learning, particularly technological limitations, inadequate access to gadgets, unreliable internet connectivity, and insufficient technology literacy among pupils. The study concluded that selected teacher characteristics influence perceptions of the effects of game-based learning in specific areas of Mathematics learning. It recommended strengthened administrative support, improved instructional resources and facilities, continued integration of game-based strategies, enhanced classroom management and digital literacy, active pupil participation, and implementation of the proposed action plan. Future researchers may conduct related studies using other variables and research settings.

Keywords: Game-Based Learning, Mathematics Instruction, Mathematical Concepts, Computational Skills, Problem-Solving Skills, Elementary Pupils

1. Introduction

Mathematics is a fundamental component of elementary education because it develops learners' ability to reason, compute, analyze information, and solve problems encountered in academic and real-life situations. However, Mathematics is often perceived by young learners as difficult because many concepts require abstract thinking, repeated practice, and the application of procedures. In this context, teachers are encouraged to employ instructional approaches that make mathematical learning more meaningful, interactive, and engaging. One

approach that has gained increasing attention is game-based learning, which incorporates structured games and playful activities into the teaching-learning process. Through games, learners may become more actively involved in mathematical tasks while developing knowledge and skills through practice, feedback, competition, cooperation, and problem-solving.

Recent research supports the potential of game-based learning to improve Mathematics learning outcomes. Liu and Tse (2023) investigated the use of a digital mathematical game among Grade 4 elementary pupils and found significant improvements in calculation abilities, particularly in calculation speed and accuracy. Their findings suggest that game-based practice can provide learners with repeated opportunities to perform mathematical operations while maintaining their interest and engagement. However, the researchers also noted that improvements may be more evident in specific aspects of calculation than in broader mathematical knowledge. Similarly, Paglomutan (2023) reported that game-based strategies had a strong influence on Mathematics learning and retention, with learners demonstrating improved ability to recall concepts and solve mathematical problems after participating in game-based activities. These findings indicate that games may serve not merely as motivational activities but also as instructional mechanisms that support the development and retention of mathematical knowledge.

Anderson (2023) further examined digital game-based learning activities in primary-grade Mathematics and reported positive effects on academic engagement, mathematical achievement, confidence, and learners' perceptions of their mathematical abilities. Nevertheless, the study emphasized that learning gains were not always immediate or consistent across learners, suggesting that the effectiveness of game-based learning may depend on the design of activities, duration of exposure, and instructional context. This observation is important because the use of games alone does not automatically guarantee improved learning; rather, games need to be appropriately aligned with learning objectives and learners' needs.

More recent evidence has provided further support for the use of game-based learning in elementary Mathematics. Cayang and Ursabia (2024), in a Philippine study involving Grade 4 pupils in Aleosan, North Cotabato, found a highly significant improvement in Mathematics performance following the implementation of game-based learning. The experimental group also obtained significantly higher post-intervention scores than the control group, demonstrating the potential effectiveness of game-based instruction in improving pupils' mathematical performance. In the same year, a systematic literature review by Suh et al. (2024) examined digital game-based learning in elementary Mathematics and identified growing scholarly interest in the approach. The review showed that research has covered different mathematical topics, game types, gameplay modes, outcomes, and research methodologies, while also identifying areas that require further investigation.

The findings of recent international research likewise demonstrate the potential of game-based learning while emphasizing the importance of appropriate implementation. Research involving elementary pupils in Romania compared digital and non-digital mathematical games and explored their effects in Mathematics learning. The study highlighted the potential of both forms of games while demonstrating that game-based learning can be applied beyond purely technology-dependent environments. In addition, Yang and Zhao (2025) examined game-based learning in Grade 1 Mathematics classrooms in Beijing and found that games can contribute to classroom efficiency, classroom interaction, and pupils' mathematical learning. However, the study identified implementation concerns involving game design, teacher guidance, student participation, classroom management, and assessment. These concerns demonstrate that the effectiveness of game-based learning is influenced not only by the presence of games but also by teachers' capacity to select, design, facilitate, and evaluate appropriate activities.

Philippine evidence in 2025 has also strengthened the argument for game-based approaches in Mathematics. Buray and Alferez (2025) examined digital game-based learning among Grade 1 learners in Misamis Oriental and reported a significant improvement in numeracy scores from pretest to posttest following the intervention. The study demonstrates the potential of digital games to support foundational numeracy among young Filipino learners. Taken collectively, these recent studies suggest that game-based learning can contribute to mathematical understanding, computational performance, engagement, and problem-solving. Nevertheless, the literature also indicates that its effectiveness may vary according to learner characteristics, teacher practices, game design, technological resources, and classroom conditions.

Despite the growing body of research, several gaps remain. First, a methodological gap exists because many recent studies have focused on experimental or quasi-experimental designs that measure learners' performance before and after a specific game-based intervention. While these designs establish evidence of effectiveness, fewer studies examine the perceptions of Mathematics teachers regarding the extent to which game-based learning affects specific dimensions of learning, particularly understanding mathematical concepts, computational skills,

and problem-solving skills. Second, a contextual gap remains in the Philippine elementary school setting. Although recent Philippine studies have examined Grade 1 and Grade 4 learners, evidence remains limited regarding the collective perceptions of Mathematics teachers across a district. Third, an implementation gap exists because challenges associated with technology, gadgets, internet connectivity, classroom management, and pupils' digital literacy are not consistently examined alongside the perceived effects of game-based learning. Fourth, a demographic and professional gap remains because relatively limited attention has been given to whether teachers' characteristics, such as age, sex, civil status, educational attainment, position, length of service, and in-service training, influence their perceptions of game-based learning. These gaps provide a rationale for examining the phenomenon from the perspective of teachers who directly implement Mathematics instruction.

Hence, the present study was conducted to determine the effects of game-based learning in teaching Mathematics for elementary pupils in selected public elementary schools in Baras District, Division of Rizal, during School Year 2025–2026. Specifically, it seeks to determine the perceived effects of game-based learning in terms of understanding mathematical concepts, computational skills, and problem-solving skills; determine whether significant differences exist in teachers' perceptions when grouped according to selected profile variables; identify the challenges encountered by teachers in implementing game-based learning; and provide a basis for a proposed action plan. The study is expected to contribute empirical evidence that may assist school administrators and Mathematics teachers in strengthening the appropriate, purposeful, and context-sensitive use of game-based learning in elementary Mathematics instruction.

2. Material and methods

2.1 Research Design

The study employed a descriptive survey research design to determine the perceived effects of game-based learning in teaching Mathematics for elementary pupils and the challenges encountered by Mathematics teachers in its implementation. This design was appropriate because it enabled the researcher to systematically describe and analyze the perceptions of the respondents based on the variables included in the study.

2.2 Locale of the Study

The study was conducted in selected public elementary schools in Baras District, Division of Rizal, where Mathematics teachers served as the primary sources of data regarding the implementation and perceived effects of game-based learning in Mathematics instruction.

2.3 Respondents of the Study

The respondents of the study were the 120 Mathematics teachers in Baras District, Division of Rizal, who represented the total population of Mathematics teachers in the identified public elementary schools during School Year 2025–2026.

2.4 Sample and Sampling Procedure

Since the study involved the total population of 120 Mathematics teachers, total enumeration sampling was employed, wherein all identified Mathematics teachers in Baras District were included as respondents to obtain a comprehensive assessment of their perceptions regarding game-based learning.

2.5 Research Instrument

The researcher utilized a researcher-made questionnaire-checklist as the primary data-gathering instrument, which consisted of sections covering the respondents' demographic and professional profiles, the perceived effects of game-based learning in terms of understanding mathematical concepts, computational skills, and problem-solving skills, and the challenges encountered in its implementation.

2.6 Data Gathering Procedure

The researcher secured the necessary permissions from the concerned school and education authorities, administered the validated questionnaire to the 120 Mathematics teachers, explained the purpose and procedures of the study, collected the accomplished instruments, and organized and encoded the gathered data for statistical analysis while observing appropriate ethical considerations and confidentiality.

2.7 Data Analysis Techniques

The collected data were analyzed using frequency and percentage to describe the respondents' profile, weighted mean to determine the perceived effects of game-based learning and the extent of challenges encountered, and appropriate inferential statistical tests, such as the t-test and Analysis of Variance (ANOVA), to determine whether significant differences existed in teachers' perceptions when grouped according to their profile variables.

2.8 Ethical Considerations

The study observed ethical principles in conducting research involving human participants. Participation in the study was voluntary, and the respondents were informed about the purpose of the research before answering the questionnaire. The information gathered from the respondents was used solely for academic purposes and was treated with confidentiality. The researcher ensured that the respondents' identities and personal information were protected throughout the research process. The collected data were analyzed and reported objectively to maintain the integrity and credibility of the study.

3. Results and Discussion

3.1 Profile of the Respondents in Terms of Selected Variables

The respondents were predominantly 31–40 years old at 38.3%, followed by those aged 51–60 years old at 21.7% and 41–50 years old at 20.8%, while those aged 21–30 years old comprised 19.2%. Most respondents were female at 76.7% and married at 70.0%. In terms of position title, Teacher I ranked first at 65.8%, followed by Teacher III at 25.0% and Teacher II at 3.3%, while only a small proportion held Master Teacher and Head Teacher positions. Regarding educational attainment, Bachelor's degree holders comprised the largest group at 46.7%, followed by MAT/MAEd graduates at 26.7% and those with MAT/MAEd units at 20.8%, while teachers with Ph.D./Ed.D units and Ph.D./Ed.D graduates accounted for 4.2% and 1.7%, respectively. In terms of length of service, teachers with 5 years and below and those with 6–10 years of experience both ranked first at 27.5%, followed by those with 11–15 years at 16.7%, while those with 16–20 years had the lowest proportion at 5.8%. As to in-service trainings attended, district-level trainings ranked first at 35.0%, followed by school-level trainings at 31.7% and regional-level trainings at 15.0%, while national-level trainings had the lowest participation at 6.7%. Overall, the respondents were largely female and married teachers, predominantly Teacher I and Bachelor's degree holders, with varied teaching experience and greater participation in district- and school-level in-service training activities.

3.2 Extent of Effects of Game-Based Learning in Teaching Mathematics for Elementary Pupils as Perceived by the Respondents with Respect to Understanding Mathematical Concepts, Computational Skills, and Problem-Solving Skills

The findings revealed that game-based learning always affects Mathematics learning among elementary pupils to a very high extent, as reflected by the composite mean of 4.55. Among the three aspects, understanding mathematical concepts ranked first with an overall mean of 4.60, followed by computational skills with 4.55, while problem-solving skills ranked third with 4.50. These results indicate that teachers strongly perceive game-based learning as an effective approach for helping pupils understand mathematical concepts, strengthen computational abilities, and improve their problem-solving skills. The highest rating for understanding mathematical concepts suggests that interactive and engaging game-based activities may help pupils grasp abstract mathematical ideas more easily by providing meaningful opportunities for exploration, practice, and application. The findings further imply that game-based learning can promote active participation, sustained attention, motivation, collaboration, and confidence among elementary pupils, thereby making Mathematics learning more meaningful and enjoyable. The results are consistent with Cayang and Ursabia (2024), who found that learners exposed to game-based learning strategies achieved significantly higher Mathematics scores than those taught through conventional methods, demonstrating the effectiveness of game-based learning in improving Mathematics performance. Similarly, Garcia and Pasia (2024) reported a significant improvement between the pre-test and post-test scores of Grade 2 learners following the implementation of game-based learning strategies, further supporting the positive contribution of game-based approaches to elementary Mathematics learning.

3.3 Significant Difference on the Perceptions of the Respondents on the Extent of Effects of Game-Based Learning in Teaching Mathematics for Elementary Pupils with Respect to the Different Aspects in Terms of Their Profile

The findings showed that no significant difference existed in teachers' perceptions when grouped according to sex and civil status, as all obtained p-values were greater than the 0.05 level of significance, indicating that male and female teachers and teachers with different civil statuses generally shared similar perceptions regarding the effects of game-based learning on Mathematics learning. In contrast, significant differences were found according to age in terms of understanding mathematical concepts, with an F-value of 3.176 and p-value of 0.027; educational

attainment in terms of understanding mathematical concepts, computational skills, and problem-solving skills, with p-values of 0.029, 0.005, and 0.044, respectively; and position title across all three aspects, with p-values of 0.002, 0.000, and 0.010, respectively. Significant differences were also observed according to length of service in terms of understanding mathematical concepts and computational skills, with p-values of 0.037 and 0.005, respectively, while no significant difference was found in problem-solving skills. Furthermore, in-service trainings attended showed significant differences in computational skills and problem-solving skills, with p-values of 0.000 and 0.004, respectively, but not in understanding mathematical concepts. These findings imply that teachers' professional and demographic characteristics, particularly age, educational attainment, position, teaching experience, and professional development, may influence how they perceive the instructional effects of game-based learning. Differences in teaching experience, exposure to innovative instructional strategies, professional responsibilities, academic preparation, and training opportunities may contribute to variations in teachers' assessment of game-based learning. The findings are consistent with Gocheva (2022), who reported that individual characteristics and professional experiences can influence educators' perceptions and utilization of game-based learning. Similarly, Matic and Bokun (2024) emphasized that teachers' educational background, knowledge, skills, and professional preparation influence their readiness and capacity to effectively integrate digital game-based learning into instruction.

3.4 Extent of the Challenges Encountered in Using Game-Based Learning in Teaching Mathematics for Elementary Pupils

The findings revealed that the respondents moderately encountered challenges in using game-based learning in teaching Mathematics, as indicated by the overall weighted mean of 3.01. The most prominent challenge was the inavailability of technology gadgets and internet access, which ranked first with a weighted mean of 3.15, followed by lack of technology literacy with 3.14 and lack of understanding of mathematical equations with 3.09. Other moderately challenging factors included too many distractions during the teaching-learning process with 3.03, lack of full cooperation among learners, lack of interest among pupils, and conflict with other learning activities, each with 2.98, while an uncondusive learning environment and existing health conditions obtained 2.93 each. The least encountered challenge was lack of adequate knowledge, with a weighted mean of 2.91, although it was still interpreted as moderately challenging. These results indicate that teachers experience manageable but notable difficulties in implementing game-based learning, particularly those associated with technological resources and pupils' digital literacy. Limited access to gadgets and internet connectivity may restrict the use of technology-supported games, while inadequate technology literacy may affect pupils' ability to participate independently and effectively in game-based activities. Difficulties in understanding mathematical equations and classroom distractions may likewise reduce the effectiveness of game-based instruction when activities are not sufficiently guided and aligned with learning objectives. The findings imply that successful implementation of game-based learning requires adequate technological resources, improved digital literacy, appropriate learner preparation, effective classroom management, and continuous teacher guidance. Addressing these concerns may help teachers maximize the instructional benefits of game-based learning and provide more engaging and productive Mathematics learning experiences. The findings are consistent with Yang and Zhao (2025), who identified challenges in implementing game-based learning in primary Mathematics classrooms, particularly in selecting appropriate games, integrating game activities into different phases of instruction, and developing suitable evaluation approaches for game-based learning.

4. Conclusion & Recommendations

The study concluded that game-based learning has a highly positive perceived effect on the Mathematics learning of elementary pupils, particularly in understanding mathematical concepts, computational skills, and problem-solving skills. Teachers consistently perceived game-based learning as an effective and engaging instructional approach, with understanding mathematical concepts receiving the highest assessment. The study further concluded that teachers' perceptions did not significantly differ according to sex and civil status, indicating generally similar views across these groups. However, significant differences were observed according to age in understanding mathematical concepts; educational attainment and position title across all three aspects; length of service in understanding mathematical concepts and computational skills; and in-service trainings attended in computational and problem-solving skills. The challenges encountered in implementing game-based learning were generally moderate, with limited availability of technology gadgets and internet access, lack of technology literacy, and difficulties in understanding mathematical equations identified as the most prominent concerns. These findings affirm that while game-based learning is a promising strategy for Mathematics instruction, its effectiveness is influenced by teachers' professional characteristics, available resources, learner preparedness, and classroom conditions.

Based on the findings and conclusions, school administrators may strengthen administrative and instructional support by providing adequate Mathematics resources, appropriate technology, reliable internet access, and conducive learning environments that support game-based instruction. Teachers may consistently integrate well-designed and curriculum-aligned game-based activities into Mathematics lessons while strengthening classroom management, learner monitoring, and instructional guidance to minimize distractions and maintain focus on learning objectives. Schools may provide relevant capability-building activities and in-service training to improve teachers' knowledge and skills in designing, implementing, and assessing game-based learning activities, particularly for teachers who have limited exposure to such strategies. Appropriate interventions may also be provided to address pupils' digital literacy, access to learning devices, participation, and understanding of mathematical concepts. Pupils may actively participate in game-based activities, cooperate with classmates, practice mathematical skills regularly, and develop positive learning habits. The proposed action plan may be implemented to address identified technological, instructional, and learner-related challenges and further maximize the benefits of game-based learning in Mathematics. Future researchers may conduct similar studies using other variables, respondents, grade levels, and research designs to further establish the effectiveness and applicability of game-based learning in Mathematics education.

5. Compliance with ethical standards

The author affirms that no conflicts of interest exist in relation to this study. The research was conducted in accordance with accepted ethical principles for human-participant research, including obtaining informed consent, ensuring voluntary participation, allowing participants to withdraw at any stage without consequence, and protecting participant confidentiality through anonymous, secure, and aggregated data management. Because the study examined psychological well-being, all research procedures were non-invasive and implemented with appropriate measures to reduce the risk of discomfort. Participants were informed of available support services should the need arise. Furthermore, the necessary institutional approvals were obtained for the administration of the research instruments and access to relevant academic records.

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