

The Effectiveness Of Game-Based Learning In Developing Arithmetic Skills Among Primary School Students

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Abstract: This study investigates the effectiveness of game-based learning in developing arithmetic skills among primary school students. A quasi-experimental design with pretest–posttest control groups was used. The experimental group was taught using educational games, while the control group received traditional instruction. Forty-eight Grade 2 students participated in the study. Data were collected through a Mathematics Achievement Test and analyzed using descriptive and comparative statistical methods. The results show that the experimental group demonstrated significantly higher improvement in arithmetic performance compared to the control group. The findings suggest that educational games can be an effective tool for enhancing young learners’ engagement and mathematical skills.

Keywords: Game-based learning, primary education, arithmetic skills, mathematics teaching, experimental study.

Introduction: In recent years, the quality of mathematics education in primary schools has become one of the central focuses of modern pedagogy. As early learners develop their first understanding of numbers, shapes, and logical reasoning, teachers play a crucial role in helping them build strong foundational skills. Researchers such as Piaget (1970) and Vygotsky (1978) emphasize that early mathematical thinking develops best when children are actively involved in learning and supported through developmentally appropriate activities. These ideas highlight the importance of using effective teaching strategies during the early stages of schooling.

Arithmetic skills are one of the fundamental competencies for primary school students. Traditional teaching methods often fail to fully engage students and maintain their interest in learning. Recently, game-based learning has emerged as an effective approach in education, offering not only the reinforcement of knowledge but also increasing students’ motivation and enthusiasm for learning.

The purpose of this study is to determine the effectiveness of game-based learning in developing arithmetic skills among primary school students. The research seeks to answer the following questions:

1. Is game-based learning more effective than traditional methods in enhancing arithmetic skills?
2. How does game-based learning affect students’ accuracy and speed in solving arithmetic problems?
3. Does this approach increase students’ interest in arithmetic?

Across the world, education systems are shifting toward interactive, student-centered approaches that promote higher-order thinking skills. Methods such as STEAM integration, game-based learning, problem-solving tasks, and hands-on activities have shown positive effects on students’ engagement and achievement (Kim & Park, 2019). In particular, play-based and inquiry-based methods have been found to increase motivation and deepen children’s conceptual understanding. As a result, many teachers and researchers are searching for practical ways to incorporate innovative approaches into primary mathematics lessons.

In Uzbekistan, ongoing reforms in the general education system emphasize the need to develop students’ logical thinking, creativity, and mathematical literacy from an early age. The updated state curriculum encourages teachers to use active learning

strategies, real-life problem situations, and collaborative work to enhance learners' understanding of mathematical concepts (MPE, 2023). However, many teachers still face challenges in selecting appropriate methods and implementing them effectively in the classroom.

Therefore, studying and analyzing modern teaching approaches in primary mathematics is essential for improving lesson effectiveness and supporting students' academic growth. This research aims to examine the impact of game-based learning on the development of arithmetic skills among primary school students and determine whether this approach is more effective than traditional teaching methods.

1. Fan Yang & Xian Zhao (2025). In their qualitative case study, Yang and Zhao examined how game-based learning was implemented in Grade 1 mathematics classes at a primary school in Beijing. Findings / Implications: They found that GBL can improve classroom dynamics, help teachers diversify activities, and foster more positive teacher-student interaction. However, they also identified challenges, such as when and how to integrate games effectively within different phases of a lesson, and how to evaluate GBL meaningfully. These insights are useful when designing your own interventions — it's not only about whether games work, but how they are used matters.

2. Zeynep Bahar Erşen & Ebru Ergül (2022) They conducted a systematic review of game-based learning in mathematics education, analyzing research published between 2017 and 2021. Findings / Implications: Their review showed that most of the studies used quantitative experimental designs, and many focused on measuring the effect of games on achievement. They also noted a growing trend in the number of studies because GBL is becoming more popular in mathematics education. This gives a strong research basis for your own study: you can align with the trend, and also justify why measuring effectiveness is important.

3. Seher Avcu (2023). In a systematic review of digital mathematics game articles from Turkey (2005–2023), Avcu synthesized how digital games have been used and studied in peer-reviewed journals. Findings / Implications: The review highlights that digital mathematics games are widely studied, but there are still gaps — for example, in long-term impacts or in diverse pedagogical contexts. For your research, this means there is precedent but also room to contribute new findings, especially in a different context (if your sample is not in Turkey).

4. Evrim Erbilgin & Gregory Michael Adam Macur (2022). Their action research focused on a subtraction

game designed to scaffold primary students' skills in solving arithmetic word problems.

Findings / Implications: They found that using a targeted subtraction game improved students' abilities to represent and solve word problems, especially in understanding problem structure. This is very relevant to your topic: not only basic arithmetic (like addition/subtraction), but also word problem solving can be positively impacted by GBL.

5. Grebenkina A.S. & Lyashko P.V. (2024). In their study published in Vestnik of Samara University, they examined the formation of students' mathematical skills using digital didactic games in primary school. Findings / Implications: They argue that digital didactic games help develop not only procedural math skills, but also logical thinking, mathematical motivation, and other cognitive skills. Their work supports the idea that GBL has a broader impact than just improving speed or accuracy — it can help shape students' overall mathematical thinking.

Based on recent research, I reviewed studies on game-based learning and its effects on arithmetic skills among primary school students. Five key studies were selected, and the main findings of each study, along with their relevance to my research topic, were analyzed.

METHODOLOGY

Research Design: This study employed a quasi-experimental design with a pretest–posttest control group structure. This design allows for comparing student progress before and after the intervention.

Participants: The research involved 48 second-grade students from a public school in Tashkent region. They were divided into two groups:

Experimental group (n = 24) – taught using educational games

Control group (n = 24) – taught using traditional methods

Both groups had similar academic backgrounds.

Instruments: A researcher-developed Mathematics Achievement Test (MAT) consisting of 25 items (addition, subtraction, and word problems) was used.

The test was reviewed by three experts, and its reliability was confirmed with Cronbach's Alpha value of 0.82.

Procedure

1. Pretest:

Both groups completed the same MAT to measure their initial arithmetic abilities.

2. Intervention (4 weeks)

Experimental group: participated in lessons involving “Number Race”, “Math Bingo”, flashcard games, and interactive group tasks.

Control group: continued with textbook-based instruction following the traditional “explain-practice” approach.

The same teacher instructed both groups to maintain consistency.

3. Posttest

At the end of the experiment, both groups completed the same MAT.

Data Analysis: Data were analyzed using descriptive statistics (means, comparisons) and visualized through a bar chart. Improvements in each group and differences between groups were examined to determine the effectiveness of the intervention.

Ethical Considerations: Participants’ identities were protected. Parental permission was obtained. No

student was disadvantaged, and game-based materials were later shared with the control group.

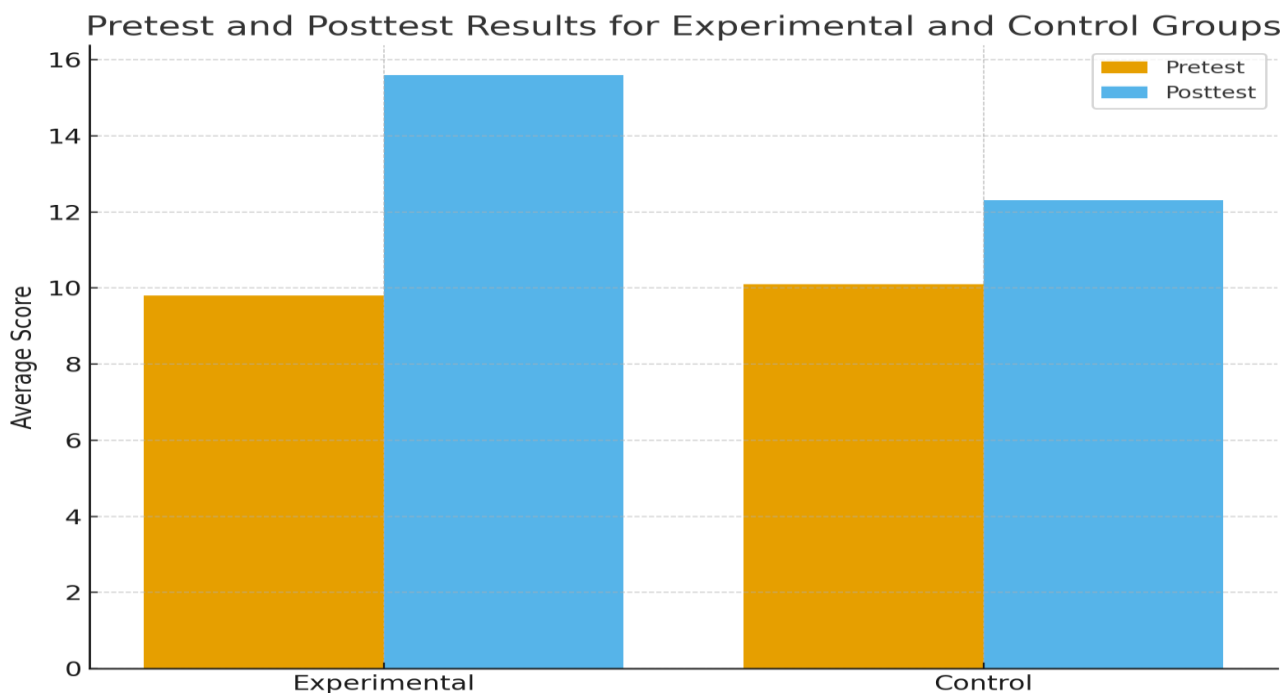
RESULTS

Pretest and posttest averages for both groups showed clear differences.

Experimental group: pretest mean = 9.8; posttest mean = 15.6

Control group: pretest mean = 10.1; posttest mean = 12.3

The experimental group’s improvement (+5.8) was significantly higher than that of the control group (+2.2). The bar chart demonstrated that game-based learning led to a greater increase in arithmetic achievement. These findings indicate that educational games positively influenced students’ motivation, accuracy, and speed in solving mathematical tasks.



DISCUSSION

The findings of this study show that game-based learning has a stronger effect on the development of arithmetic skills compared to traditional teaching methods. Students in the experimental group demonstrated higher improvement, supporting previous research suggesting that interactive, playful activities enhance children’s motivation and cognitive engagement (Piaget, 1970; Kim & Park, 2019). Game-based activities encouraged active participation, provided immediate feedback, and helped students practice arithmetic operations in enjoyable contexts.

The control group also showed improvement, which is natural because regular practice contributes to skill

development. However, their progress was notably smaller. This supports the idea that traditional methods, while useful, may not fully engage students or address diverse learning styles. The results also align with Uzbekistan’s current educational reforms that emphasize active learning and child-centered teaching. Integrating games into mathematics lessons can help teachers meet curriculum requirements while supporting students’ logical thinking and numerical fluency.

Overall, the study demonstrates that educational games not only improve academic performance but also enrich the learning atmosphere, making mathematics more enjoyable and accessible for young

learners.

CONCLUSION

In conclusion, the study concludes that game-based learning is an effective method for developing arithmetic skills among primary school students. Students exposed to educational games showed significantly greater improvement compared to those taught using traditional methods. Incorporating interactive and playful activities into mathematics instruction can enhance student engagement, motivation, and conceptual understanding. Teachers are encouraged to integrate game-based approaches regularly to improve the quality of primary mathematics teaching.

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