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PAPER

THE EFFECTIVENESS OF GAME-BASED LEARNING IN TEACHING ARITHMETIC OPERATIONS TO PRIMARY SCHOOL STUDENTS

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Abstract

This study explores the effectiveness of game-based learning strategies in teaching arithmetic operations to primary school students. By integrating educational games into mathematics lessons, the research aims to enhance student engagement, conceptual understanding, and retention of basic arithmetic skills. A quasi-experimental method was employed with control and experimental groups of grade 2 students, comparing traditional instruction with game-enhanced teaching methods. Results demonstrate a statistically significant improvement in arithmetic performance among students who engaged in game-based activities. The findings suggest that game-based methodologies not only improve learning outcomes but also foster a more enjoyable and interactive classroom environment. Implications for curriculum development and teacher training are also discussed..

Key words: Game-based learning, Arithmetic operations, Primary education, Mathematics teaching, Student engagement, Educational games, Learning effectiveness, Interactive methods, Pedagogical innovation

Introduction

In the early stages of education, mathematics plays a crucial role in shaping logical thinking and problem-solving abilities. Traditional teaching methods often fail to maintain student interest, leading to reduced engagement and suboptimal outcomes. Game-based learning (GBL) has emerged as a promising strategy to address these challenges, offering an interactive and enjoyable learning environment. This study focuses on the effectiveness of GBL in teaching arithmetic operations, a fundamental area of mathematics, in primary classrooms in Uzbekistan.

Methodology

2.1 Research Design

A quasi-experimental design was used, involving a control group (n=30) and an experimental group (n=30). Both groups were pre-tested to determine baseline arithmetic knowledge.

2.2 Participants

The participants were second-grade students aged 7–8 years from a public school in Fergana region. They were selected using purposive sampling in collaboration with school administration.

2.3 Procedure

The experimental group received six weeks of arithmetic lessons using game-based materials, including card games, dice-based tasks, and interactive board games. The control group continued with the standard textbook-based approach.

2.4 Data Collection Tools

Pre-test and post-test on addition, subtraction, and basic multiplication Observation checklists Student feedback forms

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2.5 Data Analysis

Paired-sample t-tests and descriptive statistics were used to compare pre- and post-test scores between groups.

Results

The experimental group demonstrated a mean score increase from 61.5 to 85.2, while the control group improved from 62.1 to 72.4. The difference in post-test scores between the groups was statistically significant ($p < 0.01$). Additionally, qualitative observations revealed higher levels of student engagement and enthusiasm in the game-based learning sessions.

Group | Pre-Test Mean | Post-Test Mean | Improvement
Experimental | 61.5 | 85.2 | +23.7
Control | 62.1 | 72.4 | +10.3

The analysis of pre-test and post-test scores revealed a significant improvement in arithmetic performance among the students in the experimental group who received game-based instruction.

3.1 Quantitative Results

The experimental group (n=30) showed a notable increase in their average scores, with pre-test results averaging 61.5 points, and post-test scores rising to 85.2 points. In contrast, the control group (n=30), which received traditional instruction, improved from 62.1 to 72.4 points. A paired-sample t-test indicated that the performance gains in the experimental group were statistically significant ($p < 0.01$), while the control group also showed improvement but to a lesser extent ($p < 0.05$).

Group Pre-Test Mean (SD) Post-Test Mean (SD) Mean Gain p-value
Experimental 61.5 (±7.3) 85.2 (±6.1) +23.7 < 0.01
Control 62.1 (±6.8) 72.4 (±7.0) +10.3 < 0.05

The effect size (Cohen's d) for the experimental group was 1.12, indicating a large effect of the game-based intervention on learning outcomes.

3.2 Qualitative Observations

In addition to test score improvements, classroom observations and student feedback provided deeper insight into behavioral changes and engagement:

Students in the experimental group were more motivated and eager to participate in activities.

Teachers reported that learners displayed increased attention span and collaborative skills during group-based games.

Games involving dice, number cards, and interactive story-based math tasks encouraged active learning and problem-solving.

3.3 Feedback from Teachers and Students

Post-intervention surveys revealed that:

93 percentage of students in the experimental group reported that math lessons became more enjoyable.

87 percentage of students said they felt more confident in solving arithmetic problems.

Teachers noted a decrease in math anxiety and an increase in positive classroom atmosphere.

3.4 Learning Retention (Follow-Up Test)

Three weeks after the intervention, a follow-up retention test showed that students in the experimental group maintained 87 percentage of their post-test performance, while control group students retained only 72 percentage of their post-test gains. This suggests a long-term retention advantage of game-based learning.

Figure 1

Discussion

The findings align with prior research emphasizing the benefits of interactive methodologies in early math education. Game-based learning not only improves academic performance but also fosters a positive emotional response to mathematics. This is especially important in foundational grades, where attitudes toward the subject are being formed. The study highlights the need for teacher training programs to include game-based strategies and encourages curriculum developers to incorporate playful learning components.

Conclusion

Game-based learning is an effective pedagogical tool for teaching arithmetic operations in primary school settings. It promotes deeper understanding, increases retention, and motivates students. Educators and policymakers should consider integrating GBL into the national curriculum to enhance mathematics education from an early age.

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