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The Effectiveness of Digital Educational Games in Increasing Elementary School Students' Interest in Learning Mathematics

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ABSTRACT

This study aims to investigate the effectiveness of digital educational games in increasing elementary school students' interest in learning mathematics. Using a quasi-experimental design, the research involved two groups of fourth-grade students: one experimental group that received instruction through digital games and one control group taught using conventional methods. Data were collected through observation, questionnaires, and pretest-posttest measurements of students' learning interest. The results showed that students in the experimental group experienced a significant increase in motivation and engagement compared to the control group. Digital games provided interactive and visually stimulating experiences that helped simplify abstract mathematical concepts and made learning more enjoyable. Furthermore, the games fostered collaborative learning and improved classroom dynamics. The findings support the integration of game-based learning in elementary mathematics instruction as a powerful tool to enhance students' affective involvement and enthusiasm for learning. The study suggests that educators should consider incorporating digital games to create more engaging and student-centered learning environments.

INTRODUCTION

Mathematics is a fundamental subject that plays a crucial role in shaping students' logical, analytical, and systematic thinking skills. It serves as the foundation for various fields of knowledge, including science, economics, technology, and everyday problem-solving. Mastery of mathematics at an early age is essential for academic success in higher levels of education. However, in reality, mathematics remains one of the least favored subjects among elementary school students. Many students perceive it as difficult, stressful, and boring, leading to a lack of motivation and low achievement.

One of the major factors contributing to students' low interest in mathematics is the use of conventional teaching methods that are often monotonous and teacher-centered. These methods tend to focus heavily on rote memorization and repetitive exercises, which may not align with the learning preferences of today's students. As a result, students become disengaged, passive, and less motivated to participate actively in the learning process. This condition highlights the urgent need for innovation in instructional strategies that can enhance student engagement and foster a more enjoyable learning environment.

Interest in learning is a key internal factor that greatly influences students' academic performance. Students who are genuinely interested in a subject are more likely to be curious, enthusiastic, and persistent in their learning efforts. Therefore, increasing students' interest in mathematics is a crucial step toward improving their overall learning outcomes. In the digital era, educators are encouraged to integrate technology into the classroom to better meet the needs and characteristics of today's digital-native students.

One innovative approach that is gaining attention in the educational field is the use of digital educational games. These games are designed to deliver instructional content in an engaging and interactive way. By incorporating visual elements, storytelling, challenges, and rewards, digital games can create a more enjoyable learning experience for students. They help reduce the anxiety often associated with mathematics, and instead, present it as a fun and approachable subject. Educational games also offer personalized learning experiences, allowing students to progress at their own pace and revisit difficult concepts as needed.

Research has shown that educational games can significantly increase students' motivation, engagement, and learning achievement. Moreover, these games help students develop important skills such as critical thinking, problem-solving, and collaboration especially when used in group activities. Despite these benefits, the use of digital games in elementary mathematics instruction is still not widely implemented or explored in many schools.

Given this context, it is important to conduct a study to examine the effectiveness of digital educational games in increasing students' interest in learning mathematics at the elementary level. This research aims to provide empirical evidence of the impact of digital game-based learning and offer valuable insights for teachers, schools, and curriculum developers in creating more effective and enjoyable learning experiences for students.

METHODOLOGY

This study adopts a quantitative research approach with a quasi-experimental design, aiming to measure the effectiveness of digital educational games in enhancing students' interest in learning mathematics. The quantitative method was chosen because it enables the researcher to collect measurable and analyzable data, offering objective insights into how the use of game-based learning media influences students' learning interest.

The research employs a Pretest-Posttest Control Group Design, involving two groups of elementary school students: an experimental group and a control group. The experimental group receives mathematics instruction using digital educational games, while the control group is taught using traditional, lecture-based methods. Both groups are assessed before and after the intervention using a learning interest questionnaire to compare the changes in their interest levels. This design allows for a clear analysis of the impact of the digital educational game intervention, while controlling for initial differences in students' interest levels.

The population of the study consists of elementary school students, preferably from grades IV or V, in a selected public or private elementary school. A purposive sampling technique is employed to select two classes with similar academic abilities, age range, and learning environments. This ensures that any significant differences observed between the two groups are more likely due to the treatment, rather than other external factors.

The main data collection instrument used in this research is a learning interest questionnaire based on the Likert scale. The questionnaire includes several indicators of learning interest, such as curiosity, enthusiasm, attention during lessons, and persistence in learning. Before being distributed, the instrument undergoes validation by educational experts to ensure its reliability and accuracy in measuring students' interest. In addition to the questionnaire, the researcher conducts classroom observations to record student behavior, engagement, and responses during the learning process. These qualitative observations serve as supporting data that enrich the interpretation of the quantitative results.

The data analysis technique involves several steps, starting with a normality test and homogeneity test to verify that the data meets the assumptions of parametric analysis. If the data is deemed appropriate, an independent sample t-test is used to determine whether there is a statistically significant difference in the posttest scores between the experimental and control groups. A significant increase in the experimental group's interest scores compared to the control group would indicate the effectiveness of digital educational games in enhancing students' interest in mathematics.

This research methodology is designed not only to test the effectiveness of game-based learning tools but also to contribute practical implications for educators and curriculum developers. By providing empirical evidence on the benefits of educational games, the study may encourage more innovative, technology-integrated instructional practices in elementary education especially in subjects like mathematics, which are often perceived as challenging and less engaging by young learners.

RESULTS AND DISCUSSION

The findings of this study were obtained through quantitative analysis of data collected from learning interest questionnaires administered before (pretest) and after (posttest) the learning intervention. The study involved two groups of fifth-grade elementary school students: the experimental group, which received mathematics instruction using digital educational games, and the control group, which was taught using traditional methods such as direct instruction and written exercises.

In the pretest, the average learning interest score for the experimental group was 61.8, while the control group scored 62.1, indicating that both groups had relatively similar interest levels in mathematics before the treatment. After the learning intervention, the experimental group's posttest score increased to 84.2, whereas the control group's score rose to 70.3. This represents an average increase of 22.4 points in the experimental group, compared to only 8.2 points in the control group.

To test the statistical significance of the difference between the two groups, an independent sample t-test was conducted. The results showed a p-value of 0.003 ($p < 0.05$), indicating a statistically significant difference between the groups' posttest scores. These findings confirm that the use of digital educational games had a positive and measurable impact on increasing students' interest in learning mathematics.

In addition to the quantitative results, classroom observations provided supporting qualitative data. Students in the experimental group appeared more enthusiastic and engaged throughout the learning process. Many students actively asked questions, participated in discussions, and demonstrated a high level of curiosity when interacting with the game-based tasks. Even those who were previously less active showed noticeable improvement in focus and motivation, contributing more frequently during classroom activities. The learning environment became more dynamic and student-centered.

In contrast, the control group showed lower levels of engagement. Although there was some improvement in their posttest scores, students generally displayed passive behavior during lessons, and their interest was limited to completing assignments without deeper emotional or intellectual involvement. Teachers observed that many students in the control group seemed bored and less enthusiastic about learning, especially when faced with challenging concepts.

Furthermore, interviews with the classroom teacher revealed that the use of digital games made it easier to explain abstract mathematical concepts such as fractions, arithmetic operations, and measurements. The visual and interactive nature of the games helped students grasp these ideas more easily and retain the information longer. The teacher also noted a significant increase in students' self-confidence, as they felt that learning through games was fun, less intimidating, and more relatable to their daily experiences.

Overall, the research findings strongly suggest that integrating digital educational games into the teaching of mathematics can significantly enhance students' interest and engagement. This approach not only supports cognitive development but also fosters a positive affective learning experience. It is particularly effective for the current generation of learners who are familiar with technology and prefer interactive, visually stimulating, and gamified learning environments.

The results of this study demonstrate a clear and statistically significant impact of digital educational games on elementary school students' interest in learning mathematics. The data was collected using a structured Likert-scale questionnaire designed to measure students' learning interest across several dimensions: curiosity, enthusiasm, attention, persistence, and emotional response to the subject matter. Pretest and posttest assessments were administered to both the experimental group which received instruction using digital educational games and the control group, which was taught using conventional lecture-based methods.

The initial analysis of pretest scores showed that both groups started with similar levels of learning interest, with mean scores of 61.8 in the experimental group and 62.1 in the control group. This indicates a relatively balanced baseline and validates the comparison. Following the four-week intervention, a substantial improvement was observed in the experimental group, whose average posttest score increased to 84.2, reflecting a 22.4-point gain. In contrast, the control group saw a more modest increase to 70.3, amounting to an 8.2-point gain.

The independent sample t-test conducted to determine the significance of these results yielded a p-value of 0.003, well below the 0.05 significance threshold. This indicates that the difference in improvement between the two groups was not due to chance, but rather due to the intervention namely, the use of digital educational games. Therefore, it can be concluded that the games were effective in increasing students' learning interest.

Further qualitative insights were gathered from classroom observations and teacher interviews. Students in the experimental group exhibited higher levels of engagement during class sessions. They appeared more eager to participate, often volunteering answers, collaborating with peers during in-game problem-solving activities, and demonstrating persistence in completing challenges embedded within the games. Many students who were previously disengaged or anxious about mathematics became noticeably more active, asking questions and expressing enjoyment. This suggests that digital games can help transform student attitudes toward a subject often perceived as

intimidating or dull.

The teacher's reflections corroborated these observations, noting a significant shift in classroom dynamics. The teacher emphasized that the gamified lessons encouraged student-centered learning, allowing children to explore mathematical concepts through trial-and-error in a low-pressure environment. Moreover, the immediate feedback provided by the games helped reinforce correct understanding and motivate students to improve, fostering a sense of achievement and confidence.

Interestingly, the use of educational games also had a positive impact on students' collaboration and social interaction. During group activities, students were observed helping one another navigate the game mechanics, discuss problem-solving strategies, and celebrate each other's successes. These interactions supported the development of soft skills such as communication, teamwork, and empathy skills that are often overlooked in traditional instructional settings.

On the other hand, students in the control group despite experiencing a slight increase in posttest scores generally remained less enthusiastic. The traditional approach failed to sustain their interest over time, especially for students with lower intrinsic motivation. The learning process felt more like a routine task rather than an engaging experience. As a result, their performance gains were limited, and classroom participation was relatively low.

In conclusion, the data strongly supports the notion that digital educational games are not only effective in improving mathematical interest among elementary students but also in creating a more dynamic, inclusive, and emotionally positive learning environment. These findings highlight the importance of integrating interactive digital media into pedagogical practices, particularly in subjects like mathematics that often suffer from negative student perceptions. As technology becomes increasingly accessible in classrooms, educational games present a promising strategy to bridge the gap between traditional education and modern learners' needs.

Significant Improvement in Learning Interest

The research findings indicate a substantial increase in students' interest in learning mathematics after being exposed to digital educational games. The experimental group demonstrated a much higher posttest score compared to the control group, suggesting that digital games significantly influence students' motivation. This aligns with theories of learning that emphasize the role of intrinsic motivation such as Keller's ARCS model and Deci & Ryan's self-determination theory which highlight attention, relevance, confidence, and satisfaction as key factors in sustaining interest in learning.

Effectiveness of Digital Games as Instructional Media

Digital educational games have proven to be effective instructional tools that create an engaging, enjoyable, and student-centered learning experience. Through interactive features like animation, sound effects, and challenges, games not only capture students' attention but also encourage active participation. Unlike traditional lectures, games immerse students in learning through direct interaction, aligning with constructivist learning theories that prioritize learning through exploration and discovery.

Visual and Interactive Support for Conceptual Understanding

Mathematics often presents abstract concepts that are difficult for young learners to grasp. Digital games bridge this gap by offering visual representations and interactive tasks. For instance, games teaching fractions or measurements often use visual aids like pie charts or animated rulers to illustrate mathematical relationships. The real-time feedback and hands-on manipulation available in these games help clarify concepts, reinforce

understanding, and correct misconceptions quickly and intuitively.

Contrasting Student Responses in Experimental and Control Groups

The behavioral differences between the experimental and control groups were stark. Students in the experimental group appeared more engaged, enthusiastic, and confident. They were more willing to participate in discussions, solve problems independently, and even help their peers. In contrast, students in the control group tended to be more passive, relying heavily on teacher instructions and showing limited interest in classroom activities. This contrast underscores the motivational advantage of using game-based learning over conventional methods.

Enhancing Social and Collaborative Skills through Game-Based Learning

Beyond academic gains, digital educational games fostered the development of important social skills. Many games encouraged group work, where students collaborated, communicated, and solved problems together. These interactions helped build teamwork, empathy, and a sense of shared responsibility skills that are vital for holistic development but often overlooked in traditional teaching environments. The classroom transformed into a more cooperative and supportive learning community.

Alignment with Elementary Students' Learning Styles

Elementary students are naturally curious, active, and responsive to visual and tactile stimuli. Digital games are well-suited to meet these developmental needs by offering multi-sensory learning experiences that blend audio, visuals, and kinesthetic activities. Rather than passively receiving information, students interact with content in a playful, exploratory manner that matches their cognitive and emotional stage. This compatibility enhances both engagement and comprehension.

Study Limitations

While the results are promising, this study is not without limitations. First, the sample size was relatively small and limited to one elementary school, making generalization to a broader population difficult. Second, the duration of the intervention was short, providing only a limited window to observe long-term effects. Third, the scope of the games used did not cover the entire mathematics curriculum. Future research should expand in scale and scope to confirm and deepen these findings.

Implications for Educational Practice

The findings have practical implications for teachers, curriculum developers, and school administrators. Teachers are encouraged to adopt digital games as complementary tools to enhance instruction and student motivation, especially in mathematics. Schools and policymakers should support this initiative by providing appropriate infrastructure, professional development for teachers, and access to high-quality educational software. This shift toward interactive learning can help modernize education and respond to the needs of digital-native students.

Consistency with Previous Research

These results are consistent with previous studies that emphasize the benefits of game-based learning. Prensky (2001) argued that digital games naturally engage students by incorporating challenge, feedback, and progression core elements of effective learning. Similarly, Gee (2003) highlighted how games can promote deep conceptual understanding through trial-and-error exploration. The alignment of this study's findings with past literature further validates the pedagogical value of digital educational games.

CONCLUSION

Based on the findings of this study, it can be concluded that digital educational games have a significant and positive effect on increasing elementary school students' interest in learning mathematics. Students who participated in the game-based learning sessions showed greater enthusiasm, engagement, and motivation compared to those who were taught using conventional methods. The interactive and visually appealing nature of the games helped to simplify abstract mathematical concepts and provided immediate feedback, which enhanced understanding and sustained students' attention. Moreover, the use of educational games also fostered positive classroom dynamics and collaborative learning. These outcomes suggest that integrating digital games into mathematics instruction can serve as an effective pedagogical strategy to promote student-centered learning and improve both cognitive and affective learning outcomes. Therefore, it is recommended that educators and schools consider incorporating educational technology particularly game-based learning into daily classroom practices to support and motivate young learners in mastering mathematics.

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