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Effect of Game-Based Learning with Quizizz on Cognitive Learning Outcomes in Grade IV Mathematics: An Experimental Study

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ABSTRACT

This study aims to analyze the effect of implementing the Game-Based Learning (GBL) model assisted by the Quizizz platform on improving students' cognitive learning outcomes in mathematics. The research was conducted in Grade IV at SD Inpres 2 Besusu using a quantitative approach with a quasi-experimental design and a pretest-posttest method. The evaluation instruments consisted of 12 validated and reliable questions, including 8 multiple-choice items (Cronbach's $\alpha = 0.772$) and 4 essay items (Cronbach's $\alpha = 0.833$). The results showed a significant increase in students' learning outcomes after the application of the GBL model with Quizizz. Paired sample t-test analysis revealed a significant difference between pretest and posttest scores (Sig. 2-tailed = $0.001 < 0.05$). The N-Gain score reached an average of 0.6389, which falls into the moderate category. These findings suggest that integrating game elements through Quizizz creates an engaging and interactive learning environment, enhancing students' understanding of mathematical concepts. The GBL model not only fosters motivation but also directly improves students' cognitive performance. Therefore, the model is recommended as an effective and innovative instructional strategy in primary school mathematics education.

1. Introduction

The development of education in Indonesia is a deliberate and systematic process designed to foster an inclusive and dynamic learning environment where students are actively engaged in developing their full potential (Sani, Paloloang, Rahmawati & Aras, 2024). This potential encompasses spiritual values, moral reasoning, self-regulation, intellectual growth, and essential life skills (Government Regulation No. 20 of 2003). As global transformations driven by digital technology and knowledge-based economies continue to shape educational practices, Indonesia has responded by adopting the *Merdeka Curriculum*—a flexible, student-centered framework that empowers teachers to tailor instruction according to learners' characteristics and subject demands (Lestari et al., 2023). Within this framework,

mathematics education plays a critical role, given its emphasis on developing logical reasoning, systematic thinking, and transferable problem-solving skills.

Contemporary mathematics instruction is no longer confined to rote memorization or procedural fluency. Instead, it is conceptualized as an interactive and constructive process that encourages students to actively build their understanding through exploration, reasoning, and collaborative engagement (Ryan & Bowman, 2022). In line with 21st-century skills, mathematics functions not only as a core academic subject but also as a vehicle for fostering higher-order thinking, abstract reasoning, and structured communication (Anggraini et al., 2021). However, achieving these outcomes is contingent upon the pedagogical strategies and instructional media employed by educators.

Recent research highlights that the effectiveness of mathematics instruction is significantly influenced by the integration of relevant, engaging, and technologically supported learning media. (Ulfahyana & Sape, 2024) argue that appropriate instructional media serve as a bridge between abstract concepts and meaningful understanding. In this regard, digital tools—ranging from interactive applications to educational games—offer diverse avenues for enhancing student motivation and comprehension. Firdausi, (2020) and Pulungan & Rakhmawati, (2022) both emphasize that integrating ICT-based media in the classroom can make mathematics more accessible and engaging, particularly for digital-native learners.

Despite these advances, the reality in many elementary classrooms in Indonesia remains far from ideal. Preliminary fieldwork conducted at SD Inpres 2 Besusu revealed persistent learning challenges in mathematics, particularly among fourth-grade students. Interviews with teachers and the analysis of mid-semester assessments showed that students consistently underperformed, especially when solving word problems that require contextual understanding and multistep reasoning. Observational data indicated that instructional practices were predominantly conventionally heavily on textbook-based instruction, teacher monologues, and limited student interaction. This teacher-centered approach has contributed to a lack of engagement, surface-level understanding, and minimal development of independent problem-solving skills.

Further insights gathered through student interviews underscored a discrepancy in learning experiences. While some students demonstrated enthusiasm and resilience when presented with problem-solving tasks, they still struggled when the instructional examples lacked alignment with the test questions. Conversely, a larger proportion of students displayed signs of disengagement, describing mathematics as confusing, monotonous, and overly dependent on reading materials. Their reluctance to ask questions and participate in class discussions reflected a learning environment where fear of failure and peer judgment inhibited cognitive risk-taking—an essential component of meaningful learning.

To address these pedagogical and motivational gaps, the adoption of innovative, student-centered learning models becomes imperative. One such model is Game-Based Learning (GBL), which incorporates core elements of game design into the

instructional process to foster engagement, intrinsic motivation, and concept mastery. GBL not only introduces novelty and excitement into learning but also provides immediate feedback, adaptive challenges, and collaborative opportunities that are conducive to cognitive development (Meitriani et al., 2023). When implemented thoughtfully, GBL aligns with constructivist principles and supports differentiated instruction.

The integration of digital platforms such as Quizizz within the GBL framework further amplifies its pedagogical potential. Quizizz allows teachers to design interactive quizzes that blend gamified elements with curricular content, offering students an engaging and competitive format to review, reinforce, and apply mathematical concept (Amalia, Syamsu, Darmadi, Untara, & Sani, 2024). As noted by Hafiyya and Hadi (2023), this platform not only enhances student participation but also transforms formative assessment into a dynamic learning experience. Previous studies by Ully & Dewi, (2022) and P.Kembau et al., (2016) provide empirical evidence of the superior learning outcomes achieved through GBL compared to conventional methods, particularly in improving cognitive performance and retention.

Given the clear gaps in instructional practice and the emerging evidence supporting game-based strategies, this study aims to examine the impact of the Game-Based Learning (GBL) model, supported by Quizizz, on the cognitive learning outcomes of fourth-grade students in mathematics at SD Inpres 2 Besusu. This research seeks to contribute to the growing discourse on technology-enhanced pedagogies in elementary education and offer practical insights for improving mathematics instruction in Indonesian primary schools.

2. Methodology

This study employed a quantitative experimental approach to evaluate the effectiveness of the Game-Based Learning (GBL) model supported by the Quizizz platform in improving the cognitive learning outcomes of elementary school students. A quasi-experimental design with a one-group pretest-post test approach was implemented, enabling the measurement of academic performance changes within a single experimental group before and after the intervention. The absence of a control group was mitigated by using the pretest scores as a baseline for comparison. The research was conducted at SD Inpres 2 Besusu, Palu City, involving all 18 fourth-grade students as participants. Due to the relatively small population size ($n < 30$), total sampling was employed, allowing the entire population to serve as the sample, thus ensuring internal generalizability within the school context.

The primary instruments consisted of a cognitive achievement test, observation sheets for both teacher and student activities, and semi-structured interview guidelines. The cognitive test was designed to measure students' mathematics learning outcomes and comprised 20 items: 15 multiple-choice questions and 5 open-ended essay questions. These items were developed based on the competency

indicators outlined in the Merdeka Curriculum. The instrument underwent content validation by two mathematics education experts and was subsequently pilot tested to assess reliability. Using Cronbach's Alpha coefficient, 8 multiple-choice questions and 4 essay questions were confirmed as reliable and thus used in the study. The test was administered in two phases: a pretest before the GBL intervention and a posttest after, allowing direct assessment of student learning progress. Quizizz was selected as the digital platform due to its interactive learning environment, featuring gamification elements such as scoring systems, leaderboards, and timed responses designed to enhance student motivation and engagement in real time. The instructional sessions were conducted over four meetings, each facilitated through the Quizizz live game mode and tailored to the relevant mathematics content.

In addition to the cognitive test, observation sheets were utilized to systematically record the participation, focus, and interactions of teachers and students during learning activities. These observations were conducted by two trained observers to ensure objectivity. Semi-structured interviews were carried out with selected students who achieved the highest and lowest posttest scores to capture contrasting perspectives on the learning experience using the GBL model.

Data collection was carried out directly in the classroom using a mixed-method approach. Quantitative data were obtained from the pretest and post test scores, while qualitative data were gathered from observations and interviews to complement and enrich the findings. Data analysis began with descriptive statistics to summarize pretest and posttest results, including measures of central tendency and variability. The normality of the data distribution was tested using the Shapiro-Wilk test. When data met the normality assumption, a paired-sample t-test was applied to determine whether the differences in test scores before and after the intervention were statistically significant. Additionally, the normalized gain (N-Gain) was calculated to quantify the magnitude of learning improvement relative to the maximum possible score, classifying the results into low, medium, or high categories. Qualitative data from observations and interviews were analyzed descriptively to provide contextual insights into the implementation and effectiveness of the GBL approach supported by Quizizz. This comprehensive and detailed methodology ensures that the study can be reliably replicated in similar educational settings and contributes robust evidence on the use of technology-enhanced game-based learning in elementary education.

3. Results and Discussion

The implementation of Game-Based Learning (GBL) using Quizizz in elementary mathematics focused on the topic of two-digit division and was carried out through four structured instructional phases. In the initial phase, the teacher introduced Quizizz as the digital platform to be used in class. Students responded with curiosity and enthusiasm, as it was their first experience engaging with Quizizz during lessons. This initial excitement created a strong foundation for subsequent engagement.

During the second phase—concept explanation—Quizizz's *Slides* feature was used to present the basic concept of long division. In the first session, student responses remained mostly passive, with limited active participation. However, the second session marked a notable change. Students began asking and answering questions, showed greater confidence, and were able to distinguish between divisor, quotient, and remainder. Some even volunteered to solve problems on the board, articulating their reasoning in front of the class. Figure 1 captures students immersed in the game-based activity, highlighting their heightened focus and motivation. Meanwhile, Figure 2 depicts the teacher's active role in scaffolding students' understanding, especially when they encountered difficulties during problem-solving. Together, these images illustrate the collaborative, interactive, and supportive learning atmosphere fostered through the integration of GBL with Quizizz.



Figure 1. Students participating in GBL based Quizizz activity



Figure 2. Teacher assisting students during Quizizz gameplay

The third phase centered on introducing the game mechanics, which were detailed in the student worksheets (LKPD). Although some students initially faced technical challenges—such as logging into the platform and navigating Quizizz, these issues diminished by the second meeting as students became more comfortable with the digital interface. They also displayed high attentiveness to the teacher's instructions, indicating readiness for game-based activities.

In the fourth phase, students participated in the actual gameplay using Quizizz quizzes on two-digit division. The first session involved a simulation followed by the main game. While some students struggled under pressure and technical handling, adjustments were made—such as increasing the time limit to two minutes per question. This change led to improved problem-solving performance and a more conducive learning atmosphere. Students demonstrated better understanding, higher motivation, and enthusiasm for repeating the activity to achieve better scores.

The positive impact of GBL using Quizizz is further supported by the descriptive statistics in Table 1. The average pretest score was relatively low at 25.00, indicating limited prior understanding. After the intervention, the posttest average score significantly increased to 72.33, with a wider range of performance (43 to 95), reflecting substantial learning gains.

Table 1. Descriptive Statistics of Pretest and Posttest Scores

Test	Mean	Standard Deviation	Minimum	Maximum
Pretest	25.00	7.859	15	45
Posttest	72.33	13.686	43	95

These results confirm that GBL integrated with Quizizz created an interactive and motivating learning environment. This aligns with Hafiyya & Hadi (2023), who demonstrated that Quizizz effectively boosts motivation in mathematics learning through gamification elements. The initial conceptual explanation phase using Quizizz slides ensured students gained adequate foundational knowledge, supporting Ulfahyana and Sape's, (2024) assertion on the importance of interactive media for concept mastery.

During gameplay, teacher facilitation was crucial in maintaining a conducive learning atmosphere and providing timely assistance to students struggling with comprehension and application tasks (levels C2 and C3 of Bloom's taxonomy). This intervention aligns with Ryan & Bowman (2022), who emphasize the significance of cognitive and metacognitive strategies in supporting learning processes, particularly in complex topics like division.

Furthermore, interviews with students who scored highly on the posttest revealed that the competitive and real-time scoring elements of Quizizz motivated them to stay focused and perform their best. They described the experience as more enjoyable and stimulating than traditional instruction. Similar findings were reported by Astriyana et al., (2023) and Puspitasari (2024), reinforcing GBL's efficacy in improving both academic achievement and learner motivation. Furthermore, the versatility of this approach is supported by Al Azmi et al., (2023), who confirmed the positive impact of GBL using Quizizz in language learning, highlighting its cross-disciplinary potential.

The study also underlines that GBL promotes higher-order thinking skills, as supported by Anggraini et al., (2021), who integrated digital game-based learning to develop HOTS competencies in elementary students. Additionally, increased

student motivation and engagement observed corroborate findings from Mujahidin et al., (2021) and Uly & Dewi (2022), who found Quizizz to be an effective digital tool for fostering enthusiasm and improving learning outcomes.

However, challenges emerged, such as the need for additional time to explain game rules and occasional difficulty maintaining student focus during gameplay. Addressing these issues requires optimized instructional strategies and possibly integrating collaborative learning methods, as suggested by Putra et al., (2024) to maximize the effectiveness of game-based interventions.

In conclusion, this study confirms that the Game Based Learning model supported by Quizizz significantly enhances elementary students' cognitive learning outcomes in two-digit division topics. Beyond improving academic performance, this approach fosters a stimulating and enjoyable learning environment that cultivates students' ability to apply mathematical concepts (Bloom's C3 level), making it highly suitable for elementary mathematics education.

4. Conclusion

This study successfully demonstrated that the implementation of the Game Based Learning (GBL) model supported by the Quizizz application significantly improves the cognitive learning outcomes of fourth-grade elementary students on the topic of two-digit division. The interactive and gamified nature of Quizizz effectively increased student motivation, engagement, and understanding, particularly in applying mathematical concepts as outlined in Bloom's taxonomy at the C3 level. The active role of the teacher during the learning process was crucial in guiding and assisting students, ensuring that learning difficulties were promptly addressed. These findings confirm the suitability and effectiveness of combining GBL with digital tools like Quizizz in elementary mathematics education.

For future research, it is recommended to explore the integration of collaborative learning strategies within GBL to further enhance student interaction and focus during gameplay. Additionally, investigating the long-term impact of GBL on students' critical thinking and problem-solving skills across various mathematical topics could provide valuable insights. Finally, expanding this model to different subjects and education levels could assess its broader applicability and potential benefits in diverse learning environments.

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