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Evaluating the Effectiveness of Role-Playing in Enhancing Fourth Graders' Mastery of Decimal Numbers in Mathematics

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ABSTRACT

In primary school mathematics, inadequate teaching methods remain a persistent challenge that negatively impacts students' learning outcomes. This quasi-experimental study aimed to evaluate the effectiveness of the role-playing method in improving fourth-grade students' understanding of decimal numbers at SDN Empang 2. The study involved two groups: an experimental group taught using role-play and a control group taught through conventional instruction. Fifty-three students participated, with 26 in the experimental and 27 in the control group. Data were collected using post-test scores and analyzed using an independent t-test. The results showed a statistically significant difference in learning outcomes, with the experimental group achieving a higher mean score ($M = 69.69$) than the control group ($M = 63.85$) and a p-value of 0.009 ($p < 0.05$). These findings indicate that role-playing significantly enhances students' conceptual understanding and performance in mathematics. The study contributes to the growing research on interactive teaching methods and suggests that role-playing can be an effective pedagogical tool in primary mathematics instruction.

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1. INTRODUCTION

Mathematics is a noteworthy subject across all levels of education, as it plays a critical role in the growth of students' abilities to think logically, analytically, systematically, critically, and creatively and collaborate in teams [1]. Nonetheless, teaching mathematics to students at the primary level encounters several persistent challenges that significantly impact their learning outcomes. Sari et al. [2] and Sukmana [3] underline miscellaneous learning challenges, including difficulties with irrelevant curriculum, low-quality teaching, limited resources, and various student-related factors such as cognitive ability, attitudes toward mathematics, motivation, health, and sensory development. Sari et al. [2] further detail students' challenges in mathematics, pointing to teacher-centered instruction, over-

reliance on government-provided materials, and underutilization of innovative teaching approaches. These issues contribute to the perception of mathematics as the most challenging subject, which fosters dislike and diminishes student motivation. In addition, Utari et al. [4] reveal that external factors such as lack of teacher variation, inadequate learning media and school infrastructure, and home environment also hinder students in learning mathematics. Hence, solving these intricate problems requires teachers to create engaging and interactive classroom experiences that enhance students' learning outcomes.

Initial observations in grades IV.A and IV.B at SDN Empang 2 indicated that low student learning outcomes are a significant issue in mathematics instruction. Assessment results and daily performance show that many students have not achieved the expected mathematical understanding and competence level. This issue stems from the insufficient instructional methods that have proven ineffective in providing all students with adequate opportunities for autonomous exploration of the subject matter. Limited active participation opportunities for independent discovery hinder the development of a comprehensive understanding and contribute to student disengagement, ultimately affecting their learning outcomes. Therefore, a more systematic investigation into the specific pedagogical methods is necessary to promote inclusive learning and improve academic performance for all students.

In order to tackle the challenge, teachers should employ teaching methods that incorporate suitable media, foster active student participation, and offer remedial instruction [5], [6]. One potentially effective method is role-playing, which has demonstrated its effectiveness in improving primary school students' learning outcomes in various subjects, positively impacting academic performance and developing 21st-century skills. This teaching method involves some students taking on designated roles as actors while the remaining participants serve as observers. Each student is expected to embody the character assigned to them authentically, and participating students interact with others who also play specific roles according to the chosen theme. The role-playing method emphasizes kinesthetic activities, where students are trained to develop a deeper understanding and play each role they will play [7], [1]. This method allows students to engage intensely with the learning material, moving beyond passive listening and note-taking to provide better opportunities for independent exploration.

The role-playing method has several significant strengths in the learning process, including enhancing student collaboration and motivation [8], providing opportunities for students to take on diverse roles in realistic scenarios, and connecting theoretical concepts with real-world applications [9], [10]. Furthermore, despite little exposure, this method has been demonstrated to improve students' mathematical representation abilities [11] and the growth of students' skills and attitudes[12]. Role-playing implementation procedures include topic selection, dialogue creation, practice, and performance [13]. Significant improvements in student achievement have been observed across all educational levels, from primary to high school [14], [15]. Comparative studies have even indicated that role-playing outperforms methods like virtual clinical situations in terms of improving learning experiences and achievements [16], [17], [18]. While the effectiveness of role-playing in

primary education has been demonstrated, additional research could provide more insight into its ideal application in this context.

Several previous studies have explored the use of role-playing in primary school teaching and learning, including those by Imam [14], Ar and Damaianti [19], and Unaradjan [20]. These research articles regularly demonstrate excellent outcomes about the effectiveness of implementing the role-play method in the classroom. Unaradjan [20] discovered that integrating role-playing with Problem-based Learning (PBL) and Teaching at the Right Level (TaRL) approach significantly enhanced mathematics learning outcomes and engagement levels. Imam [14] revealed a positive relationship between role-playing in a gamified environment and students' attitudes and perceived proficiency in 21st-century skills, although the associations with individual skill sub-dimensions were limited. Meanwhile, Ar and Damaianti [19] concluded from prior studies that role-playing helps enhance students' interest and learning outcomes in primary school scientific education and promotes critical thinking and social skills. The comparison reveals similar findings on enhancing students' cognitive and affective features, albeit the emphasis shifts between mathematics learning outcomes, 21st-century skill propensity, and science learning interest. The limitations of the above studies relate to assessing the effectiveness of role-playing, including challenges in isolating its impact from other teaching methods, difficulties in objectively measuring complex skills, potential self-report bias, and the need for thorough teacher preparation and well-designed implementation. Furthermore, the long-term significance and generalisability of findings warrant additional investigation.

Although previous studies have described the implementation of the role-playing method, evaluating its effectiveness requires a more rigorous research design that goes beyond analysis. This research intended to examine the role-playing method's effectiveness on mathematics learning outcomes with the topic of decimal numbers. This study was conducted at SDN Empang 2 using a quasi-experimental design involving fourth-grade students, with class IV.B designated as the experimental group and class IV.A serving as the control group. The role-playing method was selected because of its suitability with primary school students' characteristics that are naturally enthusiastic about learning through play activities and social interactions with peers. By quantitatively comparing learning outcomes between the two groups after the intervention, this research provided an in-depth analysis of the role-playing method's real impacts on enhancing students' learning outcomes, complementing the limitations of prior studies.

Based on the explanation above, this quasi-experimental study aimed to evaluate the effectiveness of the role-playing method in improving students' mathematics learning outcomes, specifically on the topic of decimal numbers. This research investigated the factual impacts of role-playing as a teaching method to enlighten the learning outcomes and quality while tackling numerous hurdles in primary school mathematics learning. The projected benefits include enhancing student academic results through active participation, real-world applications, and a creative framework for teachers to construct more exciting, cognitively challenging, and compelling learning experiences.

2. METHOD

This research examined the effectiveness of role-playing in improving mathematics learning outcomes among fourth-grade students at SDN Empang 2 on decimal numbers. This quasi-experimental study implemented a static group comparison strategy. Static group comparison is a study conducted by selecting two classes for the research. The two classes include one experimental class and one control class with the same number, then measured by doing a post-test [19]. The samples were divided into two groups: experimental and control groups. The experimental group received instruction through role-playing, while the control group was taught using conventional methods. The study population consisted of all fourth-grade students at SDN Empang 2 during the 2024/2025 academic year.

Normality, homogeneity, and equality of means tests were conducted on the sample data. Once the data were confirmed to be normally distributed, homogeneous, and having equal means, the sampling process continued using a random sampling technique. Class IV.B was selected as the experimental group, consisting of 26 students, while class IV.A served as the control group, consisting of 27 students. The instrument used to collect data in this study was a test of students' learning outcomes. Essay-type questions were employed to assess students' understanding better, as their written responses allowed more profound insights into their cognitive abilities.

Before the test was given, a trial of the test questions was conducted to determine the validity and reliability of the questions. To test empirical validity, a type of correlation statistic was implemented using the formula [20]:

$$r_{xy} = \frac{N\,\Sigma XY - (\Sigma X)(\Sigma Y)}{\sqrt{\{N.\Sigma X^2 - (\Sigma X)^2\}\{N.\Sigma AND^2 - \Sigma(AND)^2\}}} \quad (1)$$

To determine the reliability coefficient of the test questions, the alpha formula was used, which is stated as [21]:

$$r_{11} = \left(\frac{n}{n-1}\right)\left(1 - \frac{\Sigma {\sigma_i}^2}{\Sigma {\sigma_t}^2}\right) \quad (2)$$

Questions are declared valid when $r_{xy} > r_{table}$. For N = 26 and real level (α = 0.05), df = (N-2) = (26-2) = 24, then r_{table} = 0,3882. Based on the analysis results, the questions were valid and met the validity criteria and r_{11} = 0,579, which means $r_{11} > r_{table}$, so the test was valid and reliable. The scoring rubric for the essay questions consisted of several assessment criteria, such as conceptual understanding, problem-solving process, and the accuracy of the final answer. Students' responses were scored on a scale from 0 to 4, where 4 represented very good, 3 was good, 2 was sufficient, 1 was poor, and 0 was given for no response. This rubric measured student performance across three core aspects—conceptual understanding as a form of higher-order thinking, the steps taken during problem-solving to reflect their reasoning process, and the accuracy of the final answer as an indicator of precision.

The procedure for computing the percentage score was as follows: the experimental group received instruction through the role-playing method, while the control group was taught using conventional methods. The hypotheses tested in this study were:

$H_0 : \mu_1 = \mu_2$ Fourth-grade students at SDN Empang 2 who were taught using the role-playing method achieved the same mathematics learning outcomes as those taught using conventional methods.
$H_0 : \mu_1 > \mu_2$ Fourth-grade students at SDN Empang 2 who were taught using the role-playing method achieved better mathematics learning outcomes than those taught using conventional methods.
Explanation:
μ_1 = the average mathematics learning outcomes of students in the experimental class.
μ_2 = the average mathematics learning outcomes of students in the control class.

The data were tested using a t-test based on the students' results in the experimental group after the role-playing method implementation. Before the t-test, normality, and homogeneity tests were conducted to ensure the data met the necessary assumptions.

3. RESULTS AND DISCUSSION

3.1. Results

After the post-test, the data was collected from the two groups of students. 26 students in the experimental class and 27 in the control class took the post-test. The results of the post-test are shown in Table 1 below:

Table 1. Distribution of Post-test Results of Sample Class

Class	N	Max. Score	Min. Score	$\bar{X}$	S
Experiment	26	86	60	69,69	8,0537
Control	27	82	45	63,85	11,2684

Table 1 reveals that the mean score of the experimental class (69.69) is higher than that of the control class (63.85). In addition, the standard deviation in the experimental class is lower than that of the control class, suggesting more consistent student performance. Before further analysis, prerequisite tests were conducted, including normality and homogeneity tests for both sample classes, to ensure the data met the assumptions required for subsequent statistical testing.

3.1.1. Normality Test

Table 2. Normality Test Results of Sample Class

Class	N	L_0	L_{table}	P_{value}	α	Description
Experiment	26	0,1548	0,169	0,170	0.05	Normally Distributed
Control	27	0,1075	0,167	0,200	0.05	Normally Distributed

The L_0 values for each sample are lower than the expected L_{Table}, while the corresponding P_{Value} are higher than the significance threshold. This result indicates that both samples are normally distributed.

3.1.2. Homogeneity Test

Table 3. Homogeneity Test Results of Sample Classes

F_{count}	F_{table}	α	P_{value}
1,958	1,98	0.05	0,586

The value of the F_{Count} for the sample is less than the value of the F_{Table}, and the P_{Value} Exceeds the significance level. Therefore, the null hypothesis (H_0) is accepted, indicating that the sample has a homogeneous variance.

3.1.3. Hypothesis Test

After the data from both sample classes were normally distributed and had homogeneous variance, the next step was to conduct a hypothesis test using a t-test. The results of the t-test for both the experimental and control classes are presented in Table 4:

Table 4. Results of Hypothesis Testing Using T-test

Class	N	$\bar{X}$	t_{count}	t_{table}	P_{value}
Experiment	26	69,69	2,1633	0,1675	0.009
Control	27	63,85			

Based on the results, at a 95% confidence level, it was found that $t_{Count} > t_{Table}$, which meets the criterion for rejecting the H_0. Moreover, the P_{Value} = 0.009 is smaller than the significance level α = 0.05. Therefore, it can be concluded that the mathematics learning outcomes of fourth-grade students at SDN Empang 2 who were taught using the role-playing method are significantly better than conventional instructions.

3.2. Discussions

The researcher divided the students into five groups while implementing the role-playing method for the experimental class. Each group was given a simulation tool called "Empang Mart," which included a product price list, shopping receipts, and play money to mimic a real store environment. The students engaged in role-playing activities, some acting as cashiers and others as buyers. Their main task was calculating the total purchase cost and determining the correct change using the play money. This activity involved applying addition and subtraction of decimal numbers in a contextualized, meaningful setting. Upon completion, two groups were selected to present the calculations to their peers, followed by a collective review to verify accuracy. The teacher then reinforced the decimal number concepts, linking the practical simulation experience with formal mathematical understanding. These procedures are designed to assess the efficacy of role-playing combined with simulation media in teaching decimal numbers.

The results of data analysis revealed that both the experimental and control classes exhibit normal distribution and homogeneity of variance. The mean score of the experimental class (69.69) exceeds that of the control class (63.85), indicating superior

performance. Hypothesis testing using the t-test yields t_{Count} = 2.1633 and t_{Table} = 0.1675, with a significance level of α = 0.05. Given that $t_{Count} > t_{Table}$ and P_{Value} = 0.009 < α, the null hypothesis (H_0) is rejected. The findings indicate that the implementation of the role-playing method positively influences students' mathematics learning outcomes, particularly in understanding decimal numbers. The results of quantitative analysis, such as comparing pre-test and post-test scores between the experimental and control groups, demonstrate a significant improvement in the experimental group. While this statistical significance suggests the observed gains are unlikely due to chance, the practical magnitude of the role-playing method's impact warrants further consideration. Evaluating the effect size is essential to determine how much this instructional method enhances student learning in real classroom contexts.

Several factors contribute to the effectiveness of the role-playing method. First, this method promotes active learning by engaging students in meaningful, hands-on tasks that require them to apply decimal operations in realistic contexts. Acting as cashiers and buyers enhances students' focus and facilitates deeper cognitive processing through experiential learning. Second, role-playing provides concrete visualization of abstract decimal concepts, enabling students to relate place value and arithmetic operations to everyday experiences such as shopping transactions. This visualization facilitates students in connecting the decimal number topic with their daily experiences, making them easier to understand. Third, the enjoyable and interactive nature of the role-playing activities heightens students' motivation and enthusiasm, fostering a favorable socio-emotional climate conducive to learning. Collaborative interactions and peer explanations during the role-playing session reinforce understanding by encouraging students to articulate and internalize the decimal number topic from multiple perspectives.

Furthermore, social-emotional factors play a significant role in the observed improvement in outcomes in the experimental group. The interactive and fun nature of the role-playing activities fosters a favorable emotional climate in the classroom, which may increase student motivation and reduce the anxiety commonly associated with learning the decimal number topic. Enjoyment increases intrinsic motivation, making students more willing to engage with challenging tasks. Besides that, the collaborative structure of the role-playing, where students work together in the roles of cashiers and customers, encourages peer interaction, communication, and mutual support. These elements strengthen social bonds and facilitate a shared learning experience, where students can learn from each other's reasoning and perspectives, which enhances self-confidence, persistence, and learning outcomes.

The results of this research align with existing literature emphasizing the effectiveness of interactive instructional methods, such as role-playing, in mathematics learning, particularly for complex topics like decimal numbers at the primary level. Numerous studies have reported significant improvements in students' arithmetic operations, problem-solving skills, and overall mathematical achievement following the implementation of the role-playing method [22], [23], [24]. This instructional method has also enhanced student engagement, fostered creativity, and built confidence [22], [25]. Role-playing is particularly effective in supporting students' comprehension and solving

mathematical story problems [23], [24] while also strengthening their mathematical connections [26] and cognitive learning outcomes [27]. Compared to conventional teaching methods, role-playing consistently yields superior outcomes in mathematics learning [25], [28], positioning it as a suitable method to enhance student learning outcomes.

The findings have important practical implications for mathematics instruction in primary schools, particularly in teaching decimal numbers. Teachers are encouraged to incorporate role-playing as an effective method to enhance student engagement and understanding. To implement the method successfully, teachers should design scenarios relevant to students' everyday experiences and aligned with decimal concepts, for example, simulating shopping activities, following recipes, or measuring object lengths. Before beginning the activity, explaining the learning objectives, assigning roles clearly, and establishing the rules are essential. During the role-playing session, the teacher should act as a facilitator by observing the process, offering support when needed, and ensuring all students participate actively. After the activity, a debriefing is crucial to reflect on the learning experience, address any misunderstandings, and connect the simulation to the teaching material. It is also essential to balance the implementation of role-playing with other instructional methods, as excessive use may reduce its effectiveness.

Despite its promising results, several challenges and limitations may be encountered while implementing the role-playing method. First, classroom management during role-playing can be challenging, as maintaining student focus and equitable participation requires skillful facilitation. Ensuring that all students remain focused on the task and actively participate can be difficult, especially with differences in students' levels of understanding. Second, preparation time for creating scenarios and materials is considerable, and not all students may feel comfortable performing in front of peers, potentially limiting their engagement. Third, this study does not assess the long-term retention of the decimal number topic learned through role-playing, leaving open questions about the durability of its effects. Future research should explore sustained learning outcomes, investigate effectiveness across diverse mathematical topics, and examine how individual differences among students influence the success of role-playing interventions.

4. CONCLUSION

Based on the results of hypothesis testing using the t-test, students in grade IV at SDN Empang 2 who were instructed through the role-playing method demonstrated significantly higher mathematics learning outcomes than those who received conventional teaching. The results indicate that role-playing effectively enhances mathematics learning outcomes and promotes active engagement, conceptual visualization, and student motivation. This research also provides initial evidence supporting the effectiveness of role-playing as a teaching method for decimal number instruction. Nevertheless, challenges and limitations should be considered in this study's implementation.

The practical implications of these results encourage teachers to consider integrating role-playing into mathematics learning and offer valuable input for curriculum development focused on active learning strategies. Further research with more rigorous methodologies and varied educational settings is recommended to strengthen and expand upon these

findings. Future studies may also explore the long-term retention of mathematical concepts learned through role-playing and examine its effectiveness across different mathematical topics.

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