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Empirical Paper

Effectiveness of Realistic Mathematic Education and Jigsaw Assisted by Traditional Game Dakon on Numeration Ability and Learning Interest of Elementary School Students

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Abstract

Purpose: This study investigates the effectiveness of Realistic Mathematics Education (RME) and the Jigsaw learning model, both assisted by the traditional Dakon game, in improving elementary students' numeracy ability and learning interest, addressing the need for more contextual, engaging, and culturally relevant mathematics instruction.

Methodology: A quantitative field research design was employed involving fifth-grade students from SDN Rejoagung 01 and SDN Kertomulyo 01 in Trangkil District, Pati Regency. Cluster random sampling was used to select the sample. Data were collected via a numeracy test and a learning interest questionnaire and analysed using descriptive statistics, prerequisite tests (normality and homogeneity), and independent-samples t-tests in SPSS.

Results: Both the RME and Jigsaw models assisted by the traditional Dakon game significantly improved students' numeracy ability and learning interest. However, RME demonstrated superior effectiveness, achieving higher mean scores for numeracy ability (88.80 vs. 81.30) and learning interest (95.40 vs. 92.05), with statistically significant differences ($p < 0.001$).

Novelty and Contribution: The study integrates RME, the Jigsaw cooperative learning model, and the traditional Dakon game within a culturally responsive framework, providing empirical evidence that combining contextual learning, collaborative strategies, and ethnomathematics-based media enhances both cognitive achievement and affective engagement in mathematics.

Practical and Social Implications: The findings encourage teachers and schools to adopt contextual, culturally relevant approaches, particularly RME supported by traditional games, to improve mathematics outcomes, while promoting preservation of local cultural heritage and fostering numeracy, motivation, and readiness for 21st-century education.

Keywords: Realistic Mathematics Education, Jigsaw, Learning Interest, Greatest Common Divisor (GCD), Least Common Multiple (LCM)

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1 Introduction

Numeracy is one of the essential competencies of the 21st century and a key indicator of educational quality in various countries (Listi et al., 2024). Globally, numeracy is no longer defined simply as the ability to calculate, but rather as an individual's ability to use mathematical concepts and procedures contextually to analyse information, solve problems, and make decisions in everyday life (Isnaini & Aini, 2024). Various international reports, such as the Programme for International Student Assessment (PISA), place numeracy as the foundation for developing human resources that are adaptive to technological advancements and the complexity of global issues (Baharuddin et al., 2021). However, many developing countries still face the problem of low student numeracy skills due to abstract, procedural, and meaningless mathematics learning practices (Cheung et al., 2021).

In a national context, Indonesia also faces similar challenges (Koerunnisa et al., 2025). National assessment results indicate that elementary school students' numeracy skills remain in the low to moderate category. This situation is exacerbated by low interest in learning mathematics, reflected in students' perceptions that mathematics is a difficult, boring, and irrelevant subject to their lives (Akkus & Doymus, 2022). Mathematics learning practices in elementary schools are generally still dominated by a teacher-centred approach, the mechanical use of textbooks and worksheets, and an emphasis on solving routine problems (Robert, 2018). As a result, students lack contextual, collaborative, and enjoyable learning experiences, thus underdeveloping numeracy skills and learning interests.

Phenomenologically, observations in several elementary schools indicate that mathematics learning, particularly on the Greatest Common Factor (GCF) and Least Common Multiple (LCM), still faces various challenges (Bacsal et al., 2022). Students often experience confusion in differentiating between the concepts of GCF and LCM, and have difficulty applying these concepts in real-world situations. Learning that is not connected to everyday experiences causes students to quickly forget, be passive in discussions, and lack self-confidence (Sakti & Sihite, 2023). Furthermore, classroom discussions tend to be dominated by certain students, while others become passive, resulting in low numeracy skills and interest in learning mathematics

From a theoretical perspective, mathematics learning is characterised by abstract objects, thus requiring an approach capable of bridging abstract concepts with students' concrete experiences. Realistic Mathematics Education (RME) emphasises the importance of realistic contexts as a starting point for learning so that students can develop a meaningful understanding of mathematical concepts (Uyen et al., 2021). On the other hand, the Jigsaw cooperative learning model encourages social interaction, cooperation, and responsibility for learning among students. However, the implementation of these two approaches in elementary schools is often carried out separately and has not been optimally integrated.

Furthermore, the development of digital learning media, such as e-books, has been widely utilised in mathematics learning. However, most e-books still function as individual, textual delivery media, and have not fully integrated the principles of contextual, collaborative, and culturally-based learning. Yet, the demands of 21st-century learning emphasise the integration of innovative pedagogical approaches, student collaboration, and the use of social and cultural contexts as learning resources. This mismatch between the concept of individual learning media and the needs of contextual and social learning represents a theoretical gap in current mathematics learning.

Previous research has shown that the RME approach has proven effective in improving elementary school students' conceptual understanding, numeracy skills, and mathematics learning outcomes (Salsabila et al., 2020). Other research also reports that the Jigsaw cooperative learning model contributes positively to learning outcomes, self-concept, and students' interest in mathematics (Agustina et al., 2024). Furthermore, studies on ethnomathematics confirm that the integration of local culture, such as traditional games, can increase motivation, engagement, and meaningfulness of mathematics learning (Cindyana et al., 2022). However, most of these studies still examine each variable partially. Research that simultaneously integrates the RME approach and the Jigsaw model with the support of traditional game media, especially dakon, and examines their impact simultaneously on elementary school students' numeracy skills and learning interests is still very limited.

The traditional game of dakon has great potential as a medium for ethnomathematics-based mathematics learning because it incorporates concepts of counting, strategy, and logical reasoning that are relevant to students' lives (Wulandari & Astutiningtyas, 2020). The use of dakon in learning involves not only cognitive aspects but also affective and psychomotor skills, thus creating a fun and meaningful learning environment (Meliasari & Wardana, 2023). The integration of traditional games into mathematics learning aligns with the RME principle, which

emphasises real-world contexts, and the Jigsaw model, which demands interaction and collaboration among students (Dewi & Suryana, 2021).

Based on the above explanation, this research has novelty in the integration of Realistic Mathematics Education and the Jigsaw-type cooperative learning model supported by the traditional dakon game as a learning medium based on local culture. The novelty of this research lies in (1) the combination of two complementary learning approaches: RME, which emphasises realistic context, and Jigsaw, which emphasises collaboration; (2) the use of the traditional dakon game as a contextual and meaningful ethnomathematics media; and (3) comprehensive measurement of learning effectiveness on numeracy ability and learning interest of elementary school students. Thus, this research is expected to provide theoretical and empirical contributions in the development of innovative mathematics learning.

2 Methodology

Research Design

This study employed a quantitative field research approach aimed at examining the effectiveness of the Realistic Mathematics Education (RME) model and the Jigsaw learning model assisted by the traditional Dakon game on elementary school students' numeracy skills and learning interest. The study was conducted at SDN Rejoagung 01 and SDN Kertomulyo 01, located in Trangkil District, Pati Regency, Indonesia. The population of this study consisted of all elementary school students in the Kartini Cluster, Trangkil District. The sample was selected using cluster random sampling, in which intact groups (classes) were randomly chosen. Based on the random selection, two fifth-grade classes (Class V-A and Class V-B) were assigned as the research sample. This study involved four variables: two independent variables (X_1: RME and X_2: Jigsaw) and two dependent variables (Y_1: numeracy skills and Y_2: learning interest). Data were collected using a numeracy test and a learning interest questionnaire. Before their implementation, all instruments were validated by experts and piloted with sixth-grade students to ensure their appropriateness and reliability.

Population and Sample

The population of this study comprised all elementary school students within the Kartini Cluster, Trangkil District, Pati Regency. Due to limitations in time, resources, and accessibility, a representative sample was selected from the population. The sample was determined using cluster random sampling, in which groups (classes) rather than individual students were randomly selected. Two schools, namely SDN Rejoagung 01 and SDN Kertomulyo 01, were chosen, and the participants consisted of students from Class V-A and Class V-B.

Research Instruments

Two types of instruments were used in this study: a numeracy test and a learning interest questionnaire. The questionnaire was used to measure students' learning interest, while the test was designed to assess students' numeracy skills. The learning interest questionnaire consisted of 18 items measuring students' affective dimensions, including engagement, attention, interest, motivation, and social interaction. The numeracy test comprised 14 items focusing on Grade 5 mathematics topics, particularly Greatest Common Divisor (GCD) and Least Common Multiple (LCM). The test assessed students' conceptual understanding, procedural knowledge, and problem-solving abilities. All instruments were developed in accordance with the research objectives and were validated before use.

Data Collection Techniques

Data were collected using two primary methods: questionnaires and tests. The questionnaire was administered to measure students' learning interest and consisted of 18 written statements addressing affective aspects such as motivation, attention, engagement, and interest. The test method was employed to measure students' numeracy skills. The test consisted of 14 items developed based on the Grade 5 mathematics curriculum, particularly the topics of GCD and LCM. The test was objective in nature and aimed to evaluate students' conceptual understanding, procedural application, and problem-solving performance.

Instrument Validation

Instrument validation in this study included tests of validity, reliability, discrimination index, and difficulty index. Content and empirical validity were examined using the Pearson Product–Moment correlation with the assistance of SPSS software. An item was considered valid if the calculated correlation coefficient (r_calculated) exceeded the critical value (r_table). Reliability analysis was conducted using Cronbach's Alpha coefficient. An instrument was considered reliable if its alpha value exceeded 0.60, with reliability levels ranging from very low to very high. Furthermore, item discrimination analysis was used to determine each item's ability to distinguish between high- and low-performing students. The discrimination index was categorised as poor, fair, good, or excellent. The difficulty index analysis was conducted to determine the level of item difficulty. Well-constructed items were those with a moderate level of difficulty, meaning they were neither too easy nor too difficult. The difficulty levels were classified as difficult, moderate, or easy.

Data Analysis Techniques

Data analysis consisted of prerequisite testing and hypothesis testing. The prerequisite tests included normality and homogeneity of variance tests. The normality test was conducted using the Kolmogorov–Smirnov method in SPSS. Data were considered normally distributed if the significance value exceeded 0.05. The homogeneity test was applied to ensure that variances across groups were equal, which is a requirement for parametric statistical analysis. Hypothesis testing was performed using t-tests. All statistical analyses were conducted at a significance level of

0.05. Decision-making was based on the significance values and the comparison between the calculated t-value and the critical t-value.

3 Finding & Result

Normality Test Results

The Shapiro–Wilk normality tests indicated that all datasets were normally distributed. For the RME group, the significance value was 0.079, while the Jigsaw group obtained 0.061. Since all significance values exceeded 0.05, the assumption of normality was met.

Homogeneity Test Results

Levene's test showed that the variances of the groups were homogeneous. For the numeracy test, the based-on-mean significance value was 0.336 for RME and 0.944 for Jigsaw. All values were greater than 0.05, indicating that the data were suitable for further parametric testing.

Numeracy Ability Comparison

The post-test mean score of the control group was 71.80, while the RME experimental group obtained a mean of

88.80. The Jigsaw experimental group achieved a mean of 81.30. Independent samples t-test results revealed a significant difference ($p < 0.001$), indicating that RME assisted by the traditional Dakon game was more effective than the control method, and also superior to the Jigsaw model.

Learning Interest Comparison

The average learning interest score of the control group was 86.05, while the RME group achieved a higher mean score of 95.40. The Jigsaw group obtained a mean score of 92.05. Independent t-test analysis showed a significant difference ($p < 0.001$), confirming that RME assisted by the Dakon game was more effective in enhancing students' learning interest.

Overall Findings

The findings demonstrate that both RME and Jigsaw models assisted by the Dakon game significantly improved students' numeracy skills and learning interest. However, RME consistently outperformed the Jigsaw model in both dependent variables. Thus, the research hypotheses were accepted, and the null hypotheses were rejected.

4 Discussion

This section discusses the findings of the study titled "The Effectiveness of Realistic Mathematics Education (RME) and the Jigsaw Model Assisted by the Traditional Dakon Game on Elementary Students' Numeracy Skills and Learning Interest," explicitly linked to the quantitative results presented. The results of the instrument testing showed that the learning interest questionnaire was highly reliable, with a Cronbach's Alpha coefficient of 0.951, which falls into the "very strong" reliability category. Similarly, the numeracy test instruments demonstrated strong reliability across different item formats, with Cronbach's Alpha values of 0.811 for multiple-choice items, 0.736 for short-answer items, 0.720 for complex multiple-choice items, 0.740 for matching items, and 0.712 for essay items. These values (> 0.60 indicate that the instruments consistently measured students' numeracy skills. The prerequisite tests confirmed that the data met the assumptions for parametric analysis. The Shapiro–Wilk normality test revealed that the numeracy post-test scores in the RME group were normally distributed (Sig. = 0.200 > 0.05), as were those in the Jigsaw group (Sig. = 0.557 > 0.05). Likewise, the learning interest data in the RME group were normally distributed (Sig. = 0.079 > 0.05) and in the Jigsaw group (Sig. = 0.061 > 0.05). Homogeneity testing using Levene's test showed that the variances were homogeneous, with Sig. values of 0.336 for the RME numeracy data, 0.944 for the Jigsaw numeracy data, and 0.070 for the RME learning interest data (all > 0.05). Therefore, independent-samples t-tests were appropriately applied.

Regarding numeracy skills, the results indicate that the RME model assisted by the Dakon game was significantly more effective than conventional learning. The experimental group taught using RME obtained a mean post-test score of 88.80, while the control group achieved a mean score of 71.80. This difference of 17.00 points reflects a substantial improvement in students' numeracy performance. The independent sample t-test yielded a significance value of Sig. (2- tailed) = 0.000 < 0.05, indicating a statistically significant difference between the two groups. Similarly, the Jigsaw model assisted by the Dakon game also showed a significant positive effect on students' numeracy skills. The experimental group obtained a mean score of 81.30, while the control group scored 71.30, showing an increase of 10.00 points. The t-test results again revealed a significant difference with Sig. (2-tailed) = 0.000 < 0.05. When comparing the effectiveness of RME and Jigsaw directly, the RME group achieved a higher mean score (M = 88.80) than the Jigsaw group (M = 81.30). This 7.50-point difference suggests that RME is more effective in enhancing students' numeracy skills than the Jigsaw model when both are assisted by the traditional Dakon game. In terms of learning interest, the RME-assisted group also outperformed the control group. The experimental group obtained a mean score of 95.40, whereas the control group scored 86.05. This indicates an increase of 9.35 points. The independent t-test showed a significance value of Sig. (2-tailed) = 0.000 < 0.05, confirming that RME significantly improved students' learning interest.

The Jigsaw-assisted group likewise demonstrated higher learning interest than the control group, with a mean score of 92.05 compared to 87.00 in the control group, showing an improvement of 5.05 points. The t-test results confirmed this difference as statistically significant (Sig. = 0.000 < 0.05). Furthermore, when comparing RME and Jigsaw in terms of learning interest, the RME group achieved a higher mean score (M = 95.40) than the Jigsaw group (M = 92.05). This difference indicates that RME was more effective in fostering students' interest in learning mathematics. These findings support the theoretical foundations of RME, which emphasise contextual learning and the use of real-life situations to facilitate conceptual understanding. The Dakon game served as a concrete representation of abstract mathematical concepts, particularly in the topics of LCM and GCD. This contextualisation enabled students to construct their own understanding more effectively. Meanwhile, the Jigsaw model promoted social interaction, peer teaching, and cooperative learning, which positively influenced students' engagement and comprehension. However, the RME model provided stronger conceptual anchoring through real-world contexts, which may explain its higher effectiveness in both numeracy performance and learning interest. Overall, the quantitative results clearly demonstrate that both RME and Jigsaw models assisted by the traditional Dakon game significantly improved students' numeracy skills and learning interest. Nevertheless, the RME model consistently produced higher

mean scores and greater learning gains than the Jigsaw model. These results confirm that contextual and culturally responsive learning approaches not only enhance cognitive outcomes but also foster positive affective responses toward mathematics learning.

5 Conclusion

Based on the research conducted at SDN Rejoagung 01 and SDN Kertomulyo 01, Trangkil District, Pati Regency, in the academic year 2025/2026, and grounded in the results of data processing, classical assumption testing, and hypothesis testing, it can be concluded that both the Realistic Mathematics Education (RME) model and the Jigsaw learning model assisted by the traditional Dakon game significantly influenced students' numeracy skills and learning interest. However, the RME model demonstrated superior effectiveness compared to the Jigsaw model. The first data collection technique employed in this study was a numeracy test focusing on the topics of Least Common Multiple (LCM) and Greatest Common Divisor (GCD).

The results of the independent sample t-test indicated that the experimental group taught using the RME model achieved a higher mean post-test score (M = 88.80) than the experimental group taught using the Jigsaw model (M = 81.30). This difference of 7.50 points indicates that students exposed to the RME approach developed stronger numeracy skills than those taught using the Jigsaw approach. Furthermore, the significance value obtained from the t-test analysis using SPSS was Sig. (2-tailed) = 0.000 < 0.05, confirming that the difference between the two groups was statistically significant.

The second data collection technique focused on students' learning interest, which was measured using a structured questionnaire. The findings revealed that the experimental group taught using the RME model obtained a higher mean score (M = 95.40) than the Jigsaw group (M = 92.05). This result indicates a difference of 3.35 points in favour of the RME group. The independent t-test results also showed a statistically significant difference, with Sig. (2-tailed) = 0.000 < 0.05, suggesting that the RME model was more effective in fostering students' interest in learning mathematics. Overall, these findings provide strong empirical evidence that the Realistic Mathematics Education (RME) model assisted by the traditional Dakon game is more effective than the Jigsaw model in improving both numeracy skills and learning interest among elementary school students. The contextual nature of the RME approach, which connects mathematical concepts to real-life situations, enabled students to construct their understanding more meaningfully. Additionally, the integration of a culturally relevant traditional game such as Dakon enhanced students' engagement, motivation, and enjoyment in learning mathematics.

In conclusion, this study confirms that the implementation of the RME model supported by traditional game-based learning media offers a promising pedagogical alternative for elementary mathematics instruction. It not only enhances students' cognitive achievement, as reflected in higher numeracy scores, but also positively influences affective aspects, particularly learning interest. Therefore, educators are encouraged to adopt contextual and culturally responsive learning approaches to optimise both academic performance and students' motivation in mathematics learning.

Recommendation

The study recommends that elementary school teachers integrate the Realistic Mathematics Education (RME) approach supported by traditional games such as Dakon into mathematics instruction to improve students' numeracy skills and learning interest. School administrators should also provide professional development and encourage the adoption of contextual and culturally responsive teaching strategies.

Study Limitation and Future Research Considerations

This study was conducted in only two elementary schools in the Kartini Cluster, Trangkil District, using fifth-grade students, which may limit the generalisability of the findings. In addition, the study focused solely on the mathematics topics of Greatest Common Divisor (GCD) and Least Common Multiple (LCM) and employed a quantitative design without exploring students' and teachers' experiences in depth. Future studies should involve larger and more diverse samples from different regions and educational levels to enhance the generalisability of the

findings. Researchers are also encouraged to employ mixed-methods or longitudinal designs to examine the long-term impact of RME and culturally responsive learning approaches. Further research may investigate the effectiveness of integrating traditional games into other mathematics topics and different subject areas.

Practical and Social Implications

The findings demonstrate that the RME model assisted by the traditional Dakon game is an effective instructional approach for improving students' numeracy skills and learning interest. The study provides practical guidance for teachers, curriculum developers, and policymakers in designing engaging, contextual, and culturally relevant mathematics instruction that promotes active student participation and better learning outcomes. The integration of culturally relevant learning media, such as the traditional Dakon game, helps preserve local cultural heritage while fostering students' engagement with mathematics. By strengthening numeracy skills and learning interest, the approach contributes to improving educational quality and developing learners who are better prepared with the competencies required for the 21st century.

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Conflict of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

Declaration of Use of Generative AI

Generative Artificial Intelligence (AI) tools were used solely to improve language quality, grammar, and manuscript formatting. All intellectual content, analyses, and conclusions are the responsibility of the authors.

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