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Integrating Differentiated Learning Based on RME to Enhance Critical Thinking Among Elementary Learners

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Abstrak

Tujuan penelitian ini untuk melihat pengaruh pembelajaran berdiferensiasi berbasis RME pada kemampuan berpikir kritis siswa kelas V sekolah dasar. Studi ini menggunakan metode kuantitatif dengan desain kuasi-eksperimen. Penelitian dilaksanakan di kelas V dengan melibatkan 21 siswa dalam kelompok eksperimen dan 21 siswa dalam kelompok kontrol. Data dikumpulkan melalui tes, observasi, dan kuesioner. Untuk mengetahui apakah terdapat pengaruh signifikan dari penerapan RME terdiferensiasi terhadap peningkatan kemampuan berpikir kritis siswa, dilakukan analisis menggunakan uji-t. Hasil penelitian menunjukkan nilai N-gain sebesar 61,08 untuk efektivitas penerapan pembelajaran terdiferensiasi, yang termasuk dalam kategori "cukup efektif". Selain itu, nilai signifikansi yang diperoleh (sig = 0,00) menunjukkan bahwa penerapan pembelajaran berbasis RME yang terdiferensiasi memiliki pengaruh yang signifikan terhadap kemampuan berpikir kritis siswa. Dengan demikian, dapat disimpulkan bahwa pembelajaran berbasis RME yang terdiferensiasi cukup efektif dan dapat meningkatkan kemampuan berpikir kritis siswa. Hal ini karena dalam pembelajaran terdiferensiasi, guru mengidentifikasi tingkat penguasaan masing-masing siswa dan menyajikan materi dengan tingkat kesulitan yang sesuai.
Kata Kunci: Berpikir Kritis; Diferensiasi; RME

Abstract

The purpose of this study was to examine the effect of differentiated learning based on RME on the critical thinking skills of fifth-grade elementary school students. This study used quantitative methods with a quasi-experimental design. The study was conducted with fifth-grade students, involving 21 students in the experimental group and 21 students in the control group. Data were collected through tests, observations, and questionnaires. To determine whether the implementation of differentiated RME had a significant effect on improving students' critical thinking skills, a t-test was used. The results showed an N-gain value of 61.08 for the effectiveness of implementing differentiated learning, which falls into the "quite effective" category. Furthermore, the significance value obtained (sig = 0.00) indicates that the implementation of differentiated RME-based learning has a significant effect on students' critical thinking skills. Thus, it can be concluded that differentiated RME-based learning is quite effective and can improve students' critical thinking skills. This is because in differentiated learning, teachers identify each student's level of mastery and present material with an appropriate level of difficulty.
Keywords: Critical Thinking; Differentiated; RME

I. INTRODUCTION

Education plays a crucial role in preparing future generations of the nation who are of high quality and ready to face the challenges of the future (Siswanto & Ratiningsih, 2020; Hanipah & Kania, 2023). Along with the changing times, rapid technological advancements require education to continually evolve and produce individuals with high-quality skills, capable of thinking critically, creatively, systematically, and possessing problem-solving abilities, as well as having good morals (Rachmantika & Wardono, 2019). Critical thinking ability plays a vital role, as it can be used to address problems and serve as a consideration in making appropriate decisions (Siregar, 2020). Critical thinking is a process aimed at making rational decisions concerning beliefs and actions taken (Unwakoly, 2022). One subject considered to enhance critical thinking skills is mathematics.

Most educators acknowledge the importance of equipping students with Higher Order Thinking Skills (HOTS) as a crucial step in preparing a capable generation to meet the challenges of the Industry 4.0 era (Singh & Marappan, 2020). Critical thinking in the context of mathematics is highly important in the learning process, as it helps students solve problems in both mathematics and everyday life (Sulistiani, 2015; Wijaya et al., 2021). Critical thinking refers to a process of reasoning and thoughtful analysis aimed at making rational decisions based on a solid foundation of belief (Jannah et al., 2017; Aprilia & Diana, 2023). Critical thinking will enhance students' abilities to solve mathematical problems with greater depth (Fristadi & Bharata, 2015; Rahmawati et al., 2024).

Mathematics learning is not only about mastering facts, procedures, and concepts but also involves skill development (Ichsan et al., 2024). For elementary school students, it forms the basic foundation for learning mathematics. It is essential to know that at the primary school age of 7-11 years, students are still in the concrete operational stage (Bujuri & Ilmu, 2018; Napitupulu et al., 2021).

Therefore, the use of learning strategies that can increase students' enthusiasm and promote learning is required. One such strategy is the implementation of differentiated learning. Differentiation strategies have been implemented in education for many years, with the primary goal of tailoring instruction to students' interests, learning styles, and readiness levels in order to enhance their academic achievement (Alim et al., 2020; Maulidia et al., 2023; Mulyawati et al., 2022).

Differentiated learning linked to daily life helps motivate elementary students, who learn best through concrete experiences (Alim et al., 2021). Teachers must choose appropriate methods in math learning by making concepts not only abstract but also contextual and concrete. This approach supports students in grasping mathematical concepts and applying them meaningfully in everyday situations. One proven method to achieve this is through Realistic Mathematics Education (RME). RME is an instructional method that supports student participation in the process of learning mathematics through a realistic approach (Eganovita & Madiun, 2022; Ubaidillah et al., 2014).

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This instructional approach was formulated by Freudenthal and Treffers, hailing from the Netherlands (Nurfadilah et al., 2020; Lestari et al., 2022). The concept of RME is a familiar teaching model. RME underscores the idea that students' everyday life experiences, in alignment with reality, are taken as the initial guiding principles for the learning process (Lestari et al., 2020; Hamid & Afriansyah, 2024). In addition to selecting the appropriate approach, teachers should also be skilled in employing captivating instructional models (Asyafah, 2019; Badar & Bakri, 2022). Learning through the utilization of RME is enjoyable as students are able to explore their own comprehension through contextual problems presented within it (Arrafi & Masniladevi, 2020; Afriansyah, 2022). Through RME, mathematics education will hold more significance for students (Tumangger et al., 2024).

According to the research by Alditia et al (2024) reports that elementary school students' critical thinking skills remain low, which may be attributed to two main factors: students' internal factors and teacher quality. Similarly, research by Rohmawati & Fathoni (2022) also found that elementary students' thinking skills are still at a low level. The study employed HOTS-oriented math problems to foster students' critical thinking skills. In addition, the study by A. S. Dewi et al (2023) conducted in a fourth-grade elementary school class with 52 students, revealed that 18 students demonstrated moderate thinking skills, while 22 students exhibited low thinking skills. Additionally, research conducted by Suryana, et al (2022). The study, which involved 65 elementary school students, revealed that 27 students exhibited very low levels of critical thinking, another 27 demonstrated low-level skills, only 9 students showed moderate abilities, and just 1 student was identified as having high critical thinking skills.

Critical thinking represents a vital 21st-century competency that students need to develop to effectively navigate and respond to global challenges (Sari & Wardhani, 2020; Tang et al., 2020; Tajuddin et al., 2023). However, in reality, many elementary school students still struggle to develop critical thinking skills due to uniform teaching practices that fail to consider students' varying abilities and learning needs. This issue highlights the urgency of developing adaptive and contextual learning strategies.

This research holds significance as it proposes a solution by combining the Realistic Mathematics Education (RME) approach with the principles of differentiated instruction, which has been rarely explored empirically in the context of elementary education. The novelty of this research lies in the implementation of RME tailored to the readiness levels and characteristics of elementary students, thereby enhancing learning effectiveness and more optimally fostering critical thinking skills. This approach is not only theoretically relevant but also practically applicable in addressing the diverse learning challenges found in classrooms.

Based on the described background, this research seeks to examine the impact of applying differentiated instruction within the framework of Realistic Mathematics

Education (RME) approach in enhancing the critical thinking skills of fifth-grade elementary students in the context of geometry, specifically on the topic of cubes and cuboids. Accordingly, the research question addressed is: Does RME-based differentiated instruction significantly improve fifth-grade students' critical thinking in geometry topics such as cubes and cuboids?

II. METHOD

Face setting with fifth-grade students at SDN 07 Mandau during the second semester of the 2022/2023 academic year. The study involved two groups, each consisting of 21 students an experimental group and a control group. Employing a quantitative method with a quasi-experimental design, a pretest was administered to both groups to evaluate their baseline critical thinking skills. The experimental group received instruction through a differentiated Realistic Mathematics Education (RME) approach whereas the control group was taught using conventional methods. Following the intervention, a posttest was administered to assess the extent of improvement in students' critical thinking abilities.

The study was conducted over four sessions with controls to minimize external influences. Both groups had the same teacher, similar classroom settings, and consistent materials. Student participation was monitored, and outside learning was discouraged. This ensured the impact measured came solely from the differentiated RME-based learning. The research instrument included pretest and posttest questions based on critical thinking indicators. The indicators for assessing critical thinking skills are as follows:

Table 1.
Indicators of Students' Critical Thinking Skills

Aspects	Students Responses	Score
Identifying Concepts	Does not provide the expected concept to solve the problem	0
	Provides a concept that is not relevant to problem solving	1
	Provides a concept but the solution is incorrect	2
	Provides the correct concept and solution	3
Problem Solving	Does not understand the problem/ no response	0
	Does not pay attention to the problem requirements/ lacks accurate interpretation of the problem	1
	Plans a solution but the concept is not appropriate	2
	Formulates the problem/ constructs a mathematical model effectively	3

This study employed statistical techniques to analyze the quantitative data. After confirming the assumptions of normality and homogeneity, an independent samples t-test was performed to compare the results between the control and experimental groups.

III. RESULT AND DISCUSSION

This research seeks to determine the effectiveness of using differentiated instruction rooted in the Realistic Mathematics Education (RME) framework to foster critical thinking skills among fifth-grade elementary students. Before implementation, interviews with the classroom teacher and a student learning needs assessment were conducted to determine learners' levels of readiness, areas of interest, and preferred ways of

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learning. These findings informed the design of differentiated instruction and the development of tailored student worksheets. A pretest on solid figures (cubes and cuboids) was administered to the experimental group to assess prior knowledge. Students were then grouped based on learning style profiles, determined through questionnaires, to guide the differentiated instruction for the topic of volume.

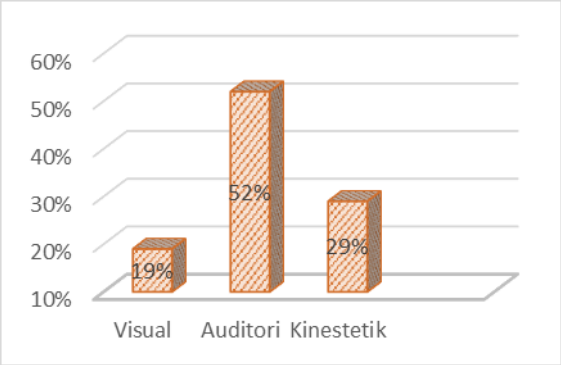

Figure 1. Students' Learning Style Mapping.

Students' learning styles in the experimental group reveals that out of 21 students, 11 are auditory learners, 6 are kinesthetic learners, and 4 are visual learners, indicating a dominant auditory learning preference.

Students were grouped based on their identified learning styles, generating enthusiasm among them. However, some students initially struggled to understand the purpose of the grouping and requested to be with familiar peers. The dominance of auditory learners led to an unequal distribution, prompting the teacher to further divide this group by gender. During the first session, several auditory learners had difficulty understanding instructions in the Differentiated Student Worksheets and preferred working individually. After receiving guidance, students became more engaged, and real objects such as cubes and cuboids were used to support their understanding. Some deviations from the planned sequence occurred due to time constraints and the need for group conditioning.

The second session proceeded more smoothly, following the differentiated learning plan. Students remained in their assigned groups, and the teacher opened the session with routine activities and a motivational song about volume. Challenges from the previous session were no longer present. The teacher reinforced the rationale behind the groupings and learning objectives. The session included differentiation in content, process, and product to accommodate students' learning styles effectively.

This learning approach aims to enhance students' critical thinking skills through differentiation in content, process, and product. Content differentiation involves distributing worksheets tailored to students' learning styles. In process differentiation, the teacher guides students to understand the concept of volume in cubes and cuboids using methods suited to their learning styles: visual learners observe demonstrations, auditory learners engage in discussions, and kinesthetic learners manipulate physical objects. Product differentiation allows students to present their understanding through assignments aligned with their strengths and preferences.

The Realistic Mathematics Education (RME) approach supports critical thinking by emphasizing contextual, real-life

problem-solving. Grounded in constructivist and meaningful learning theories, RME encourages students to actively build their understanding through exploration and reflection. As a result, students show diverse ways of grasping volume concepts: visual learners use diagrams, auditory learners discuss their findings, and kinesthetic learners engage with hands-on materials to draw conclusions and present results.

Overall, the instructional process in the experimental group proceeded effectively, with students demonstrating active engagement and collaborative interaction within their assigned groups. The teacher provided guidance to help each group understand the tasks in the Differentiated Student Worksheets. At the end of the second session, a posttest on the volume of cubes and cuboids was administered to assess student learning outcomes.

A quantitative approach with a quasi-experimental design was utilized in this study, involving both an experimental group and a control group. The objective was to assess students' critical thinking skills before and after the application of differentiated instruction based on the Realistic Mathematics Education (RME) approach, specifically on the topic of volume. A pretest was administered to both groups to evaluate their initial skill levels.

Table 2.
Pre-test Results of Students' Achievement

The Thinking Skill	Experiment Class				Control Class			
	X_{min}	X_{max}	$\bar{x}$	s	X_{min}	X_{max}	$\bar{x}$	s
Critical	30	55	41.43	7.27	30	55	41.90	7.16

Based on the data in Table 2, students in the experimental class had critical thinking scores between 30 and 55, averaging 41.43 with a standard deviation of 7.27. Similarly, the control class showed scores within the same range, with a slightly higher average of 41.90 and a standard deviation of 7.16. These comparable score ranges and standard deviations suggest that both groups had equivalent ability levels, justifying their assignment as experimental and control groups in the study.

Pre-test findings indicate that the critical thinking abilities of students in both the experimental and control groups were relatively comparable and generally remained below the expected standard. Following the pre-test, the experimental group received RME-based differentiated learning designed according to students' learning styles (visual, auditory, kinesthetic), as shown in Figure 1. The control group continued with conventional instruction. Following three instructional sessions utilizing differentiated RME-based learning. The results of the post-test are displayed in Table 3.

Table 3.
Results of Students' Post-Test

The Thinking Skill	Eksperiment Class				Control Class			
	X_{min}	X_{maks}	$\bar{X}$	s	X_{min}	X_{maks}	$\bar{X}$	s
Critical	60	95	76.90	8.87	45	75	59.29	8.40

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Table 3 reveals a positive shift in students' learning outcomes following the post-test. The experimental group, taught through RME-based differentiated instruction, attained a mean score of 76.90. Meanwhile, the control group experienced a more modest gain, with an average score of 59.29. Although both groups improved, the control group's scores remained below average and did not show significant gains. The findings indicate that the application of differentiated instruction grounded in the RME approach produced a more significant improvement in students' learning outcomes compared to traditional teaching methods.

Learning based on Differentiated Realistic Mathematics Education (RME) is effective in enhancing students' critical thinking skills as it integrates two key approaches: RME, which focuses on contextual problem-solving, and differentiated instruction, which accommodates diverse learning styles (Fitriani et al., 2020; Khasanah, Wiryanto, et al., 2025; Mulyawati et al., 2022). This instructional approach is consistent with constructivist theory, which posits that learners actively build their own understanding through engagement and interaction with their learning environment (Putri et al., 2024). According to Piaget, meaningful learning takes place when students actively construct their own understanding, rather than passively receiving information from external sources passively receive information (Daodu et al., 2024; Zhang, 2022). The RME approach reinforces this theoretical perspective by introducing real-world problems that prompt students to think critically and formulate their own solutions.

To evaluate the effectiveness of the differentiated learning implementation, an n-gain score analysis was conducted. The results of this analysis are presented in Table 4.

Table 4.
N-gain Test Results

The Thinking Skill	Eksperiment Class		Control Class	
	N-Gain Mean	Category	N-Gain Mean	Category
Critical	61,08	Moderately effective	29.65	Not Effective

Table 4 shows that the average n-gain score reached 61.08, placing it in the 'moderate effectiveness' category. This indicates that the use of differentiated instruction based on the RME approach has a fairly positive impact on the learning process. To determine whether this method significantly influences students' critical thinking abilities, an independent t-test was conducted, with the results displayed in Table 5.

Table 5.
Results of t-test for The Implementation of Differentiated Learning Based on RME on Students' Critical Thinking Abilities

Independent Samples Test		
	Levene's Test for Equality of Variances	t-test for Equality of Means

Independent Samples Test

		F	Sig.	t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Thinking Skill	Critical	1.224	.275	7.76	40	.000	31.43	4.05

Referring to the data presented in Table 5, the t-test significance value (sig) is 0.00. In line with the decision rule for the t-test, where a sig value < 0.05 indicates statistical significance, the alternative hypothesis (H_a) is accepted. This result confirms that the implementation of differentiated learning based on the RME significantly contributes to improving critical thinking in elementary students.

The RME method significantly contributes to fostering critical thinking by focusing on real-life problem-solving situations that are meaningful to students *(Khasanah, Yuli, et al., 2025). A*ccording to Gravemeijer *(1994),* Realistic Mathematics Education (RME) encourages students to explore mathematical concepts through meaningful contextual representations, enabling them to identify patterns, develop arguments, and evaluate generated solutions. Furthermore, theory of meaningful learning asserts that students grasp concepts more effectively when the material is linked to real-life experiences (Siregar & Sari, 2020; Hozaima & Subaidi, 2023; Wulandari et al., 2023; Zagoto et al., 2022). In RME, students engage in discussions and reflections to evaluate problem-solving strategies, reinforcing their critical thinking skills.

In addition to RME, differentiated learning also contributes to enhancing students' critical thinking abilities. Theory of differentiated learning, each student has a unique learning style; therefore, flexible teaching approaches tailored to individual characteristics can improve learning effectiveness (Dalila et al., 2022; Pozas et al., 2020; Qorib, 2024). In content differentiation, teachers present material in various formats, such as diagrams for visual learners, discussions for auditory learners, and manipulative activities for kinesthetic learners. This differentiation ensures that each student comprehends concepts in the way that best suits their preferences, enabling them to actively analyze and evaluate information (Haelermans, 2022; Mulyawati et al., 2022; Westbroek et al., 2020). Meanwhile, process differentiation allows students to learn concepts through diverse strategies, such as independent exploration, group discussions, or hands-on experiments, fostering deeper understanding. Additionally, product differentiation enables students to express their understanding through various assignments, such as projects, reports, or presentations, encouraging them to think analytically and creatively when constructing arguments (Mulyawati et al., 2022).

The integration of Realistic Mathematics Education (RME) principles with differentiated instruction enables students to gain a more profound understanding of mathematical concepts while simultaneously fostering the development

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of their critical thinking skills (Ariati et al., 2023; Hakim & Sitepu, 2024; Mulyawati et al., 2022). Instead of merely memorizing formulas or procedures, they are encouraged to analyze, evaluate, and develop solutions based on real-world situations. By providing challenges appropriate to students' cognitive development levels and fostering an environment that supports exploration, Differentiated RME-Based Learning creates a more meaningful and effective learning experience in improving critical thinking skills.

At its core, the implementation of differentiated learning rooted in RME is underpinned by the provision of mathematics education intrinsically connected to students' daily lives. This instructional methodology fosters active engagement with real-life scenarios necessitating critical thinking for resolving mathematical challenges. Differentiated learning appreciates the diversity inherent in each student's abilities and learning preferences, necessitating tailored pedagogical experiences. In this research, the application of differentiated learning is harmoniously linked to the real-life contexts of students, thereby fostering critical thinking during the process of problem-solving. The conclusions of this research are congruent with the findings of Dewi (2020) and Hadi et al (2022), who ascertained that differentiated learning significantly amplifies students' critical and creative thinking abilities, respectively. These outcomes firmly underscore the efficacy of differentiated learning in bolstering critical thinking capabilities, substantiating its potential for effective implementation in teaching contexts.

IV. CONCLUSION

Results of the implementation of RME-based Differentiated Learning has a statistically significant and positive effect on the development of critical thinking abilities among elementary students. This approach encourages students to think critically, relate mathematics to real-life contexts, and develop creative problem-solving abilities. The effectiveness of Differentiated RME-Based Learning lies in its combination of contextual problem-solving and instruction tailored to individual learning needs. RME promotes understanding through exploration and reflection, while differentiation ensures that each student learns according to their potential. To strengthen the generalizability of these findings and further validate the approach's effectiveness, future research should include larger, more diverse sample groups and adopt more rigorous research designs.

Through the integration of the Realistic Mathematics Education (RME) approach and the principles of differentiated instruction, this model offers an alternative learning strategy that is responsive to students' diverse abilities and contextual in content delivery. The findings of this study provide practical guidance for teachers in designing learning processes that are not only meaningful but also capable of more effectively fostering the development of critical thinking skills. Future research is recommended to involve larger and more diverse samples to enhance the

generalizability of the results and to employ more rigorous experimental designs to further examine the effectiveness of this model.

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