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Differentiated instruction strategies to improve mathematics learning outcomes in elementary school

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Abstract

Mathematics learning in elementary schools often faces persistent challenges arising from the heterogeneity of students' abilities and learning needs, which frequently hinder the achievement of optimal learning outcomes. Although differentiated instruction has been widely recognized as a promising pedagogical approach for addressing learner diversity, empirical evidence on its effectiveness in mathematics education at the elementary level particularly within the Indonesian context remains limited. This study contributes to filling this gap by examining the impact of differentiated instruction on the mathematics learning outcomes of elementary school students. Employing a quantitative approach with a pre-experimental one-group pretest–posttest design, the study involved 43 purposively selected fifth-grade students from SDN Belendung III during the 2023/2024 academic year. Data were collected through pretest and posttest essay assessments consisting of 10 items and analyzed using SPSS version 24 with a paired sample t-test. The analysis revealed a significant improvement in students' learning outcomes, with a calculated t-value of 42.187 exceeding the critical value of 2.02, thereby confirming the positive effect of differentiated instruction. These findings highlight the potential of adaptive teaching practices to enhance students' conceptual understanding and problem-solving skills in mathematics. The study underscores the importance of implementing evidence-based differentiation strategies to promote more inclusive and effective mathematics instruction. The results also provide a foundation for future research to investigate the long-term sustainability of differentiated instruction, its role in shaping students' attitudes toward mathematics, and the comparative efficacy of specific differentiation techniques.

Keywords: Adaptive Teaching, Differentiated Instruction, Elementary Education, Mathematics Learning Outcomes, Pre-Experimental Design

Introduction

Mathematics is a foundational discipline taught from elementary through higher education and is widely recognized for its role in cultivating students' critical thinking, logical reasoning, and problem-solving abilities (Harahap, 2023; Abayeva et al., 2024; Duma et al., 2024). As a compulsory subject, it equips learners with competencies necessary for addressing real-world problems and fosters intellectual development across academic domains (Jawad, 2022; Amsari et al., 2023; Djafar et al., 2023; Zhou & Cayaban, 2024). Despite its centrality, many students perceive mathematics as difficult and intimidating (Anwar et al., 2022), which often reduces motivation and engagement, thereby constraining comprehension and overall performance.

The central aim of mathematics education is to enable students to understand, internalize, and meaningfully apply mathematical concepts. However, many learners struggle to connect abstract mathematical ideas with practical applications, hindering their progression. Addressing this issue requires pedagogical innovations that accommodate diverse learning needs. Differentiated instruction, defined as the intentional adaptation of teaching strategies, content, and assessment methods to address learner variability, has been proposed as one such approach (Samsudi et al., 2024). The present study examines the impact of differentiated instruction on elementary students' mathematical achievement, with the goal of providing empirical evidence regarding its potential to enhance conceptual understanding and performance.

Internationally, mathematics is consistently regarded as one of the most challenging subjects, with student achievement levels frequently lagging behind those of other disciplines. These challenges are often reinforced by conventional, teacher-centered practices that prioritize uniform instruction over learner diversity. The lack of engaging, student-centered pedagogies diminishes motivation and constrains opportunities for deeper conceptual development (Amsari et al., 2023). Importantly, these issues transcend cultural and geographical contexts, highlighting the global relevance of more adaptive approaches. Recent scholarship underscores the promise of learner-centered strategies, such as differentiated instruction, in promoting equity and improving mathematics learning outcomes.

In Indonesia, the Merdeka Curriculum emphasizes student-centered pedagogy and active learner participation as mechanisms for improving educational quality. Nonetheless, classroom practices remain largely teacher-centered, limiting opportunities for engagement and interaction. This reliance on uniform instruction disproportionately affects students with varied cognitive abilities, thereby exacerbating learning disparities. Differentiated instruction has therefore been recognized as a promising pedagogical strategy, enabling teachers to adjust content, processes, and assessments to meet the needs of diverse learners. Empirical studies demonstrate that this approach enhances students' conceptual understanding, motivation, and achievement in mathematics. Against this backdrop, the present study investigates the implementation of differentiated instruction in Indonesian elementary schools, aiming to generate insights into its contribution to mathematics learning outcomes and broader educational reforms.

The Merdeka Curriculum, as articulated in the Minister of National Education Regulation No. 22 of 2016, mandates student-centered instruction and active participation. Rather than replacing prior frameworks, it refines existing policies to support more effective learning. Differentiated instruction is aligned with this vision, as it acknowledges variation in students' interests, readiness levels, and learning profiles, and resists the "one-size-fits-all" approach to teaching (Santika & Khoiriyah, 2023). By providing flexible instructional pathways tailored to individual needs, differentiated instruction enables more equitable and effective learning experiences (Wahyuningsari et al., 2022)

The theoretical foundation of differentiated instruction rests on the premise that students differ in readiness, learning profiles, interests, and talents, requiring varied forms of instructional support. Differentiation fosters meaningful and collaborative learning by aligning pedagogy with learners' needs. Its primary objective is to provide equitable opportunities for all students, regardless of background or ability. Research highlights its effectiveness in enhancing engagement and achievement: the importance of tailoring instruction to learners' profiles, while Puspitasari et al. (2020) argue that it addresses classroom diversity by promoting inclusivity, collaboration, and enjoyment.

Within the Merdeka Curriculum framework, differentiation is positioned as a critical means of addressing diverse learning needs (Firmansyah et al., 2024). By accommodating individual variation in knowledge acquisition, differentiated instruction ensures that learning experiences are both personalized and student-centered. Beyond inclusivity, this approach enhances instructional efficiency and relevance, as it increases motivation and engagement while strengthening conceptual mastery. In mathematics, where variation in students' conceptual understanding is pronounced, differentiation is particularly significant for developing problem-solving skills, logical reasoning, and critical thinking.

Mathematics learning outcomes represent the competencies students acquire through instructional experiences. These outcomes encompass cognitive, affective, and psychomotor domains and are commonly expressed through grades or other evaluative symbols (Halim et al., 2020). Improving outcomes requires pedagogies that render mathematics meaningful and engaging. Differentiated instruction facilitates this by grouping learners according to readiness, interests, and learning styles, and by adapting content, processes, and products accordingly (Halil et al., 2024). Implementation typically proceeds in stages: (1) conducting diagnostic assessments to identify learners' profiles, (2) designing varied instructional pathways supported by appropriate resources and formative assessments, and (3) evaluating and refining practices to ensure continued effectiveness.

Empirical evidence supports the effectiveness of differentiated instruction in mathematics education. Sabarikun and Purnomo (2023), for instance, found that its application in geometry instruction improved students' understanding and performance. Similarly, Rahmayanti et al. (2023) reported broader positive effects on mathematics learning outcomes. Nonetheless, research on its practical application in elementary mathematics classrooms remains limited (Rahmadani et al., 2023). Barriers such as insufficient teacher preparedness, challenges in selecting appropriate strategies, and sustaining student engagement continue to impede implementation.

Given these gaps, this study seeks to examine the effects of differentiated instruction on mathematics learning outcomes among Indonesian elementary students. Specifically, it aims to generate empirical evidence on how differentiation influences understanding, engagement, and overall performance. By addressing the practical challenges of implementing differentiated instruction, this research contributes to the discourse on student-centered pedagogy and offers guidance for aligning classroom practice with the principles of the Merdeka Curriculum.

Methods

This study was conducted at Belendung III Public Elementary School, Klari, Karawang, during the 2023/2024 academic year. A quantitative approach was employed to examine the effect of differentiated instruction (DI) on students' mathematics learning outcomes. The research adopted a pre-experimental one-group pretest–posttest design, which allows for comparison of students' performance before and after the intervention. This design was selected because it provides a suitable framework for evaluating the preliminary effectiveness of instructional innovations in authentic classroom settings where practical limitations restrict the inclusion of control groups. Pre-experimental designs are commonly employed in educational research were controlling for external variables is challenging yet initial evaluative evidence is necessary.

Research Procedure

The research was conducted in four sequential stages:

1. Pretest administration – A mathematics test was administered to participants prior to the intervention to establish baseline competencies.
2. Implementation of differentiated instruction – The intervention was carried out across multiple sessions. Instructional strategies were systematically adapted to students' readiness levels, learning profiles, and interests, drawing on DI principles.
3. Posttest administration – Following the intervention, a posttest equivalent in difficulty to the pretest was administered to assess potential learning gains.
4. Data analysis – Results from the pretest and posttest were analyzed to evaluate the impact of DI on mathematics learning outcomes.

Research Setting and Participants

The population of this study comprised all fifth-grade students at Belendung III Public Elementary School, totaling 93 students. From this population, a purposive sampling strategy was employed, yielding a sample of 43 students. Purposive sampling was chosen because it enables the deliberate selection of participants who meet specific study criteria. In this study, the inclusion criteria were: (1) active participation in regular mathematics classes, and (2) feasibility of participating in DI implementation within the designated timeframe.

Data Collection

Data were collected using written mathematics tests (pretest and posttest). The test items were developed in accordance with curriculum standards to ensure alignment with expected learning objectives. Prior to administration, the items underwent expert validation procedures to establish both content validity and reliability, thereby enhancing the rigor of measurement.

Data Analysis

Data analysis involved both descriptive and inferential techniques. Descriptive statistics, including mean and standard deviation, were used to summarize students' performance on pretests and posttests. To examine the statistical significance of learning gains, a paired-sample t-test was conducted at the 0.05 significance level. If the obtained p-value was less than 0.05, the intervention was considered to have a statistically significant effect on students' mathematics learning outcomes. This analytic approach allowed for the identification of performance changes attributable to DI while controlling for individual differences through within-subject comparison.

Results and Discussion

In this study, differentiated instruction strategies were systematically designed to address the diverse learning needs of students in developing an understanding of cubic and rectangular prisms. The strategies were applied across three dimensions content, process, and product to ensure that students with varying levels of mathematical proficiency could meaningfully engage with the material.

Content differentiation was implemented by adjusting the complexity of instructional materials and problem-solving tasks in accordance with students' readiness levels. Learners were grouped based on their prior mathematical knowledge. Students with higher proficiency were challenged through tasks involving real-world applications that required advanced reasoning, while those with lower proficiency were supported with structured guidance, scaffolded exercises, and step-by-step problem-solving strategies. This approach allowed all students to access the curriculum at a level appropriate to their abilities while maintaining high expectations for learning.

Process differentiation was applied through the use of varied instructional methods to accommodate different learning styles and preferences. A combination of direct instruction, hands-on exploration, and collaborative learning activities was employed to foster student engagement. Visual learners benefited from diagrams, manipulatives, and digital tools that clarified the concept of volume. Auditory learners engaged in peer discussions and guided explanations, while kinesthetic learners interacted with three-dimensional models to physically explore the structure of cubic and rectangular prisms. Opportunities for individual, pair, and group work were provided to allow students to engage with the material in ways aligned with their learning preferences and comfort levels.

Product differentiation was used to account for students' varied ways of demonstrating understanding. Rather than relying exclusively on traditional written tests, multiple assessment formats were offered. Some students constructed concept maps to illustrate the procedures for calculating volume, while others presented oral explanations of their problem-solving processes or applied their knowledge to authentic contexts, such as measuring and calculating the volume of objects in the classroom. These varied assessment opportunities ensured that students could demonstrate their learning in ways that aligned with their strengths, thereby providing a more comprehensive evaluation of their mathematical understanding.

The implementation of these differentiation strategies encouraged students to take an active role in the learning process, promoting both motivation and comprehension. This instructional framework created conditions for meaningful engagement and supported the development of problem-solving abilities. The following section presents the results of the study, focusing on students' performance in solving essay-based tasks on calculating the volume of cubic and rectangular prisms. In the initial stages of problem solving, students demonstrated competence in identifying known and required information before proceeding to the calculation phase, thereby establishing the foundation for subsequent mathematical reasoning.

The analysis of student responses, as illustrated in Figure 1, reveals a distinct pattern in how learners approached problem-solving tasks related to calculating the volume of cubic and rectangular prisms. The majority of students adopted a structured approach, beginning with the identification of the given information and the unknown quantities, which reflects an understanding of the fundamental stages of problem solving. Their ability to select and apply the correct formula indicates that essential mathematical concepts related to volume calculation had been internalized.

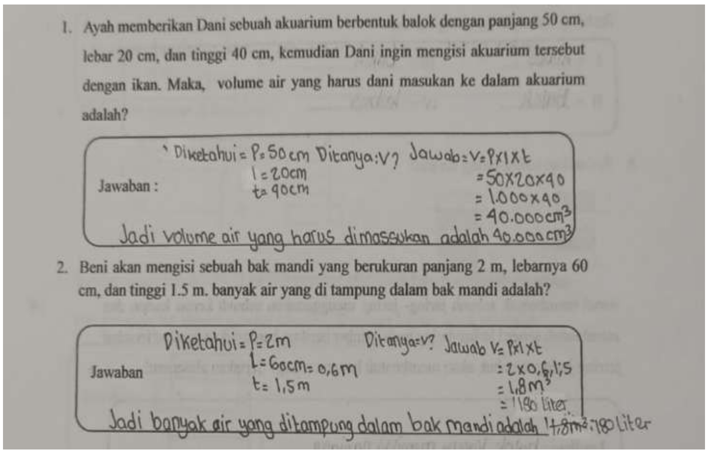


Figure 1. Student type A's Answer

A closer examination of the responses shows that most students followed a logical sequence: they recorded the known values from the problem statement, selected the appropriate formula, and applied it correctly to obtain the solution. This consistency suggests that the differentiated instructional strategies implemented in the study effectively supported both procedural fluency and conceptual understanding. Students who demonstrated higher levels of mathematical competence extended beyond procedural accuracy. These students employed flexible approaches, such as decomposing composite solids into smaller units or verifying their answers through alternative methods, including unit conversions. Such flexibility indicates a deeper level of conceptual mastery, aligning with mathematics education goals of fostering critical thinking and strategic problem solving.

Nonetheless, variation in student responses was observed, particularly among those who struggled with problem solving. Some students experienced difficulties in correctly identifying the known and required elements, which in turn led to the inappropriate selection of formulas. Others omitted key steps in their calculations, suggesting the need for additional scaffolding to help them break down complex problems into smaller, manageable components. These findings echo prior research emphasizing the importance of structured guidance and individualized support in developing problem-solving skills.

Overall, the response patterns suggest that differentiated instruction exerted a positive influence on students' mathematical performance. Most students were able to complete the tasks accurately, demonstrating that instructional practices tailored to students' readiness levels, learning profiles, and interests can enhance engagement and comprehension. The use of varied instructional approaches such as hands-on activities, visual representations, and collaborative problem solving appears to have reinforced understanding and facilitated knowledge retention.

Despite these encouraging outcomes, the variations in responses also highlight areas for instructional refinement. Future teaching strategies should place greater emphasis on error analysis, enabling students to reflect critically on mistakes and refine their problem-solving approaches. Moreover, targeted interventions may be necessary for students requiring additional support to ensure that all learners develop a robust conceptual foundation in mathematics.

Taken together, the analysis of student responses underscores the effectiveness of differentiated instruction in improving both problem-solving abilities and mathematical comprehension. The findings demonstrate that tailoring instruction to learner diversity not only promotes inclusivity but also enhances the overall quality of mathematics learning experiences.

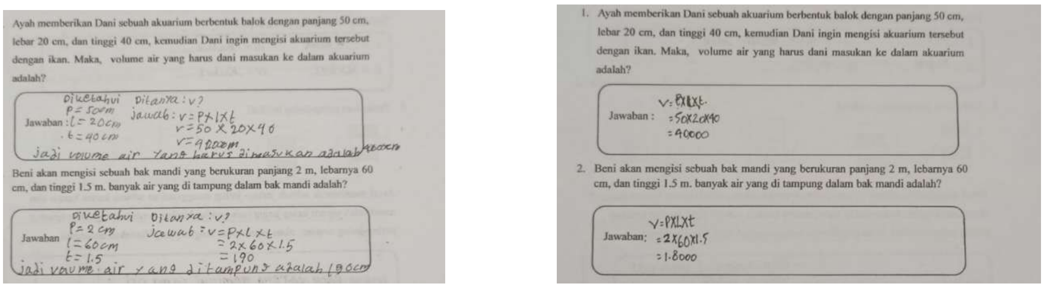
Before presenting the test results, it is important to describe the differentiated instruction strategies implemented in this study. Differentiation was designed to address students' varying levels of readiness, learning profiles, and interests, ensuring equitable access to meaningful mathematical learning experiences. The intervention was structured across three dimensions: content, process, and product.

Content differentiation was applied by adjusting the complexity of mathematical problems based on students' proficiency levels. Learners with stronger foundations were assigned complex, multi-step problems requiring higher-order reasoning, whereas those needing additional support engaged with guided, step-by-step tasks scaffolded with prompts. This ensured that each learner encountered an appropriate level of challenge, preventing disengagement while sustaining motivation.

Process differentiation involved the use of multiple instructional strategies tailored to diverse learning styles. Visual learners were supported with diagrams and concrete representations of rectangular prisms, kinesthetic learners constructed three-dimensional models, and verbal learners engaged in peer discussions to articulate reasoning. Targeted smallgroup instruction was also provided for students experiencing difficulty, thereby offering individualized support in mastering essential concepts.

Product differentiation was implemented during assessment, allowing students to demonstrate understanding through varied formats. While some students completed traditional written calculations, others explained their reasoning orally or represented their solutions visually. This flexibility enabled students to draw on their strengths, fostering confidence and deeper comprehension of volume concepts.

The effectiveness of these strategies is reflected in the student responses analyzed in Figures 2a and 2b. In Figure 2a, the student demonstrated a systematic approach by identifying the given and required information, applying the correct formula, and solving for the volume of a rectangular prism. However, errors emerged in unit notation and computational accuracy, as the student omitted the appropriate unit and miscalculated one result despite correct initial steps. These errors indicate the need for greater emphasis on precision in units and computational accuracy.



(a) (b)

Figure 2. Student Answer

In contrast, the student response in Figure 2b illustrates a different pattern. The student successfully applied the volume formula and arrived at the correct solution in one item but failed to document the given and required information systematically, suggesting reliance on memorization rather than structured problem solving. Additionally, as with Figure 2a, unit notation was omitted, pointing to a recurring issue among students. In a subsequent item, the student was unable to obtain the correct result, highlighting the need for further scaffolding to help learners decompose complex problems into manageable steps.

These variations in responses highlight both the strengths and limitations of differentiated instruction. On the one hand, many students demonstrated improved ability to apply formulas and engage with problem-solving tasks. On the other hand, gaps remained in systematic reasoning, accuracy, and the consistent use of mathematical conventions such as unit notation. This underscores the necessity of continuous instructional refinement, including explicit reinforcement of structured solution steps and targeted interventions focused on error analysis.

Overall, the findings suggest that differentiated instruction contributed positively to students' engagement, procedural fluency, and conceptual understanding of volume. After the intervention, students increasingly demonstrated the ability to identify given and required information, apply appropriate formulas, and provide complete answers, including correct units and conclusions. Nevertheless, the persistence of certain errors indicates that differentiated strategies must be complemented with focused support in mathematical communication and precision to ensure that all learners achieve mastery in problem-solving.

Description of Pretest and Posttest Results

The descriptive statistics of the pretest and posttest, generated through SPSS 24, provide important insights into the impact of differentiated instruction on students' mathematical performance.

As shown in Figure 3, the pretest scores reflected wide variability in achievement. Scores ranged from 30 to 80, with clustering around 55 and 65, where seven students obtained each of these values. Several students scored below 50, indicating substantial gaps in prior knowledge and limited mastery of the fundamental concepts. This distribution highlights the heterogeneous nature of the classroom and the need for instructional approaches capable of addressing diverse learning profiles.

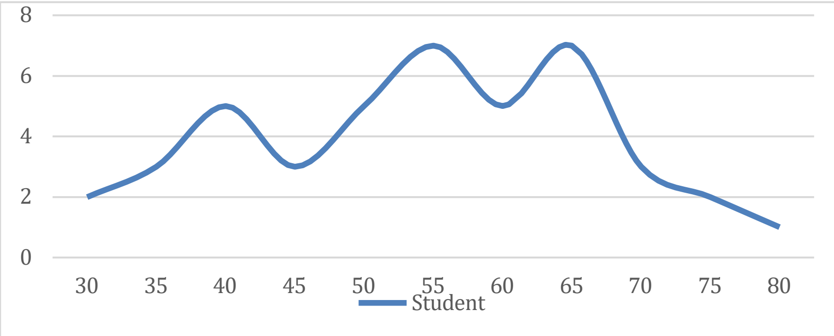


Figure 3. Graph of *Pretest* Average Scores

Following the intervention, the posttest results revealed a marked improvement in overall achievement. The lowest score increased from 30 to 45, while the highest score rose to 90, attained by four students (Figure 4). The distribution of scores shifted upward, with most students scoring between 65 and 85. Specifically, eight students achieved 65, seven scored 75, and five scored 80 or 85. This clustering toward higher values demonstrates that differentiated instruction supported not only low-achieving students but also enabled those with moderate proficiency to consolidate their skills and achieve greater accuracy in problem-solving.

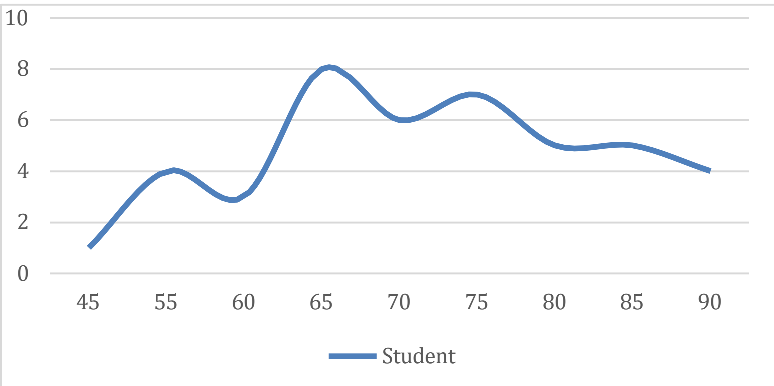


Figure 4. Graph of *Posttest* Average Scores

The comparative analysis of pretest and posttest outcomes suggests that differentiated instruction effectively enhanced student engagement, comprehension, and procedural fluency. The decline in the number of students scoring below 50 underscores the benefits of targeted scaffolding for struggling learners, while the sustained high performance among stronger students indicates that enrichment opportunities within differentiated instruction prevented stagnation and encouraged deeper mathematical reasoning. The reduction in extreme score variations further suggests that this approach helped bridge the performance gap across the classroom.

Pedagogically, these findings align with previous research emphasizing the efficacy of student-centered and flexible teaching strategies in mathematics education. By adjusting the content (problem complexity), process (instructional methods), and product (forms of assessment), differentiated instruction allowed students to engage with mathematical concepts at their individual readiness levels. This flexibility contributed to meaningful progress among weaker students while simultaneously fostering higher-order thinking in more advanced learners.

In conclusion, the pretest and posttest data provide strong empirical evidence that differentiated instruction positively influenced students' mathematical performance. The intervention not only improved accuracy in applying formulas and solving problems but also promoted inclusivity by reducing disparities in achievement. These findings reinforce the value of differentiated instruction as a pedagogical approach that enhances both equity and excellence in mathematics learning.

Description of Pretest and Posttest Results

The results of the Levene's test, as shown in Table 1, indicate a significance value of 0.389, which is greater than the conventional threshold of 0.05. This finding confirms that the data meet the assumption of homogeneity of variance, suggesting that score variability is relatively consistent across groups. Consequently, differences in student performance can be attributed to the instructional intervention rather than unequal variance in the data. Meeting this assumption strengthens the validity of subsequent statistical analyses and ensures that comparisons between pretest and posttest scores are both reliable and unbiased.

Table 1. Test of Homogeneity of Variances (Pretest and Posttest)

Variable	Levene Statistic	df1	df2	Sig.
	0.749	1	84	0.389

The results of the one-sample t-test presented in Table 2 further validate the effectiveness of differentiated instruction. The calculated t value of 42.187 far exceeds the critical value (ttable = 2.02), with a significance level of $p < 0.001$. This outcome provides strong statistical evidence to reject the null hypothesis (H0) and accept the alternative hypothesis (H1), indicating that differentiated instruction had a significant effect on student learning outcomes.

Table 2. One-Sample t-Test Results

Test Value = 0	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference
Experiment	42.187	42	0.000	71.97674	68.5337 – 75.4198

The large mean difference (71.98) and the narrow confidence interval (68.53–75.42) further emphasize the robustness of this finding. These results demonstrate that improvements in posttest scores cannot be attributed to random variation but rather reflect the positive influence of differentiated instruction on students' mathematical understanding and problem-solving abilities.

Taken together, the homogeneity and hypothesis test results provide compelling evidence that differentiated instruction was an effective intervention. The statistical significance of the findings, combined with their consistency with prior research, underscores the importance of adaptive instructional approaches in fostering student engagement, conceptual comprehension, and overall achievement in mathematics.

Mathematical Cubes and Rectangular Prisms

The focus of this study lies within the domain of solid geometry, "Solid geometry is a portion of space bounded by a set of points located on the entire surface of the structure." Solid geometry constitutes an important area of mathematics because its forms are frequently encountered in daily life. Developing a strong understanding of these concepts is therefore essential for students. In this study, the subject matter is restricted to two fundamental three-dimensional shapes: the cube and the rectangular prism as shown in Figure 5.

Figure 5. Students' activities in the learning process

The findings of this research demonstrate the effectiveness of differentiated instruction in enhancing students' conceptual understanding and problem-solving skills in solid geometry. The implementation of this pedagogical approach led to increased student engagement and improved learning outcomes, as evidenced by the posttest results. These findings are consistent with those of Afifah et al. (2024), who reported that differentiated instruction positively influences student activity levels by encouraging active participation in teacher–student interactions. Similarly, Nawati et al. (2023) found that differentiated learning fosters deeper engagement, ultimately contributing to higher academic achievement.

This study extends the existing body of literature by illustrating that differentiated instruction is particularly effective in mathematics learning at the elementary level. Unlike traditional one-size-fits-all methods, differentiated instruction provides tailored learning opportunities that address variations in student readiness, interests, and learning preferences. This conclusion is in line with the work of Miqwati et al. (2023), who observed that differentiated strategies enhance students' motivation and comprehension. Importantly, the present findings advance prior research by providing empirical evidence on the influence of differentiation on specific mathematical competencies. In particular, the results indicate that differentiated instruction significantly improves students' ability to apply formulas for volume, structure problem-solving steps logically, and interpret outcomes accurately.

The implications of these findings are noteworthy. Mathematics educators are encouraged to adopt differentiated instruction to better accommodate diverse learning needs and foster meaningful engagement. Furthermore, the study highlights the importance of sustained professional development for teachers, equipping them with the skills required to design and implement effective differentiated learning environments. Future research could explore the long-term effects of differentiated instruction on students' mathematical reasoning and examine its applicability to other domains of mathematics or across different subject areas. By integrating and extending previous findings, this study contributes to the growing body of evidence that positions differentiated instruction as a powerful pedagogical framework for improving mathematics learning outcomes.

Conclusion

The implementation of differentiated instruction has a significant positive effect on the mathematics learning outcomes of fifth-grade students at SD Negeri Belendung III, particularly in the topic of cubes and rectangular prisms. The comparison between students' pretest and posttest results indicates a marked improvement in achievement, with the mean posttest score (71.97) substantially exceeding the pretest mean (54.18). Hypothesis testing further supports these findings, as the calculated t-value (42.187) was considerably higher than the critical t-value (2.02), thereby rejecting the null hypothesis and confirming the effectiveness of the intervention. These results provide empirical evidence that tailoring instruction according to students' readiness, interests, and learning profiles enhances conceptual understanding, strengthens problem-solving abilities, and promotes higher academic performance in elementary mathematics.

Despite these promising outcomes, the study is not without limitations. The research was confined to a single school context with fifth-grade students, which restricts the generalizability of the findings across different educational settings, grade levels, and cultural contexts. The analysis also relied predominantly on short-term quantitative measures (pretest and posttest scores), leaving questions about long-term retention, the durability of problem-solving skills, and shifts in students' mathematical attitudes unanswered. Furthermore, the study examined differentiated instruction in general terms without isolating the relative impact of specific strategies, such as tiered assignments, flexible grouping, or individualized learning plans. These limitations suggest the need for broader and more nuanced investigations to capture the full scope and complexity of differentiated instruction in mathematics education.

In light of these limitations, several recommendations for future research emerge. Subsequent studies should adopt larger and more diverse samples, extending across grade levels and school contexts, to strengthen the external validity of findings. Longitudinal research designs would be particularly valuable in assessing the sustained impact of differentiated instruction on mathematical reasoning, conceptual retention, and student attitudes toward the subject. Moreover, comparative analyses of specific differentiation techniques could provide clearer guidance for practitioners regarding which strategies are most effective for particular learner profiles. Incorporating qualitative methods, such as classroom observations, teacher interviews, and student reflections, would also yield richer insights into the processes through which differentiated instruction influences engagement and learning. By addressing these areas, future research can contribute to a more comprehensive understanding of differentiated instruction as a pedagogical framework, advancing both theoretical perspectives and practical approaches for fostering inclusive and effective mathematics education.

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Conflicts of Interest

The authors declare no conflict of interest regarding this publication. All ethical aspects, including plagiarism, misconduct, data fabrication or falsification, double publication or submission, and redundancies, have been fully addressed.

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