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Implementation of Differentiated Learning to Improve Students' Numeracy Skills in the Merdeka Curriculum

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ABSTRACT

Low numeracy achievement among elementary school students remains a major challenge in the implementation of the Merdeka Curriculum in Indonesia. One of the contributing factors is the use of teacher-centered learning approaches that do not adequately accommodate students' diverse learning needs and abilities. Therefore, differentiated learning is considered a promising strategy to improve students' numeracy skills through flexible and student-centered instruction. This study aimed to analyze the effectiveness of differentiated learning implementation in improving elementary school students' numeracy skills within the Merdeka Curriculum framework. The study employed a quasi-experimental method using a pretest-posttest control group design. The participants consisted of 60 fifth-grade students divided into an experimental group and a control group. Data were collected through numeracy tests, classroom observations, and documentation. The data were analyzed using descriptive statistics, N-gain analysis, normality and homogeneity tests, paired sample t-tests, and independent sample t-tests. The findings revealed that students in the experimental group achieved significantly higher numeracy improvement compared to the control group, with a high N-gain category. Differentiated learning enhanced students' mathematical reasoning, contextual problem-solving, participation, and learning motivation. In conclusion, differentiated learning effectively improves elementary school students' numeracy skills and supports the student-centered principles of the Merdeka Curriculum.

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1. INTRODUCTION

Numeracy skills have become one of the essential competencies that students must master in the twenty-first century because numeracy is closely related to students' ability to solve problems, interpret data, think logically, and apply mathematical concepts in everyday life. In the Indonesian educational context, strengthening numeracy has become one of the main priorities in

the implementation of the Merdeka Curriculum, particularly after the publication of the National Assessment (ANBK) results which indicated that students' numeracy achievement remains relatively low. Mustika et al. (2025) reported that only approximately 30.66% of elementary school students in Indonesia achieved the minimum numeracy competency standard in the 2021 ANBK assessment. This condition indicates that many students still experience difficulties in understanding mathematical concepts contextually, analyzing quantitative information, and applying mathematical reasoning in real-life situations. The low achievement of numeracy skills has become a serious educational concern because numeracy competency is not only associated with mathematics learning outcomes but also with students' critical thinking ability, problem-solving skills, and future academic success.

Several previous studies identified various factors contributing to the low level of students' numeracy achievement in elementary schools. One of the dominant factors is the persistence of teacher-centered learning practices that limit students' active involvement during the learning process. Pudjastuti et al. (2024) explained that many teachers still implement conventional teaching approaches where students passively receive information rather than actively construct knowledge through exploration and problem-solving activities. Such instructional practices tend to create monotonous classroom environments that reduce students' interest and motivation to learn mathematics. Similarly, Setiawan et al. (2024) emphasized that ineffective teacher competencies, limited learning media, minimal educational facilities, and the lack of innovative teaching strategies significantly contribute to students' weak numeracy performance. In addition, Larasati et al. (2025) and Wahyudi et al. (2025) argued that mathematics instruction often fails to connect mathematical concepts with students' real-life experiences, causing students to perceive mathematics as abstract, difficult, and irrelevant to daily life. Consequently, students struggle to develop meaningful understanding and practical numeracy competencies.

The challenges of numeracy learning also reflect broader issues related to instructional design and classroom diversity. Students possess different levels of readiness, interests, learning profiles, and cognitive abilities, yet many learning activities still apply uniform instructional approaches for all learners. This condition creates learning gaps because students with lower readiness levels frequently experience difficulties following lessons, while high-achieving students may feel insufficiently challenged. Within the framework of the Merdeka Curriculum, differentiated learning has emerged as one of the major pedagogical approaches intended to address students' diverse learning characteristics. According to Noviyanti et al. (2025), differentiated learning emphasizes adjustments in learning content, learning processes, learning products, and learning environments based on students' readiness, interests, and learning profiles. This approach aligns with the philosophy of the Merdeka Curriculum, which promotes flexible, student-centered, and competency-based learning experiences.

Differentiated learning is considered highly relevant for numeracy instruction because numeracy development requires active engagement, contextual learning experiences, and adaptive teaching strategies that accommodate diverse student needs. Indrawatiningsih et al. (2024) explained that differentiated instruction enables teachers to design learning activities with varying levels of complexity and learning support, allowing students to learn according to their abilities and learning pace. Through differentiated learning, students are encouraged to participate more actively in mathematical exploration, collaborative problem-solving, and reflective thinking processes. Dinana et al. (2024) further argued that differentiated learning creates more inclusive classroom environments because all students receive equal opportunities to succeed based on their individual potential and characteristics. Therefore, differentiated instruction is not merely a teaching strategy but also a pedagogical effort to foster equitable and meaningful learning experiences.

The implementation of differentiated learning in the Merdeka Curriculum is also closely connected with diagnostic assessment practices. Diagnostic assessment serves as an important foundation for identifying students' readiness levels, learning interests, strengths, and difficulties before teachers design instructional activities. Kholid et al. (2024) explained that teachers implementing differentiated learning commonly utilize various diagnostic tools such as Quizizz, questionnaires, interviews, and digital assessment platforms to map students' learning profiles. The

information obtained from diagnostic assessment is then used to organize flexible grouping, develop differentiated modules, and provide varied learning activities that match students' needs. Such practices demonstrate that differentiated learning emphasizes adaptive instructional planning rather than uniform classroom treatment. Consequently, students can engage in learning activities that are more meaningful, relevant, and motivating.

Several empirical studies have shown that differentiated learning positively influences students' literacy and numeracy competencies. Indrawatiningsih et al. (2024) found that differentiated instruction significantly improved elementary school students' literacy and numeracy skills, with a numeracy N-gain score of 0.58 categorized as moderate improvement. The study revealed that differentiated activities allowed students to better understand mathematical concepts because learning tasks were adjusted to their readiness levels and learning styles. Likewise, Rosita et al. (2025) reported that integrating Problem-Based Learning with differentiated instruction significantly improved students' numeracy literacy, resulting in an N-gain score of 0.56. These findings indicate that differentiated learning supports students' mathematical understanding by providing flexible learning pathways and contextual problem-solving experiences. Furthermore, differentiated instruction helps students become more engaged and confident in learning mathematics because learning activities feel more accessible and meaningful.

In addition to differentiated learning, several student-centered instructional models have also demonstrated positive effects on students' numeracy development. Realistic Mathematics Education (RME), for instance, emphasizes contextual problem-solving and authentic learning experiences that connect mathematics to students' daily lives. Fauzan et al. (2024) found that RME effectively improved numeracy and mathematical literacy because students were encouraged to actively construct mathematical understanding through contextual exploration. Similarly, Problem-Based Learning (PBL) has been shown to significantly improve numeracy literacy by positioning students as active problem-solvers rather than passive recipients of information (Rahmah et al., 2023; Pudjastuti et al., 2024). Other approaches, such as ethnomathematics and contextual learning, also demonstrated positive impacts on numeracy achievement because they integrate cultural experiences and local contexts into mathematics instruction (Larasati et al., 2025; Lubis et al., 2025). These instructional models share common principles with differentiated learning because they prioritize student-centered learning, contextual experiences, flexibility, and active participation.

Despite the growing body of literature discussing differentiated learning and numeracy development, several research gaps remain evident. First, many studies on differentiated learning within the Merdeka Curriculum primarily focus on students' critical thinking skills and general learning outcomes rather than specifically examining numeracy competencies. Noviyanti et al. (2025) emphasized that further studies are needed to investigate how differentiated instruction can be effectively implemented in mathematics and numeracy learning contexts. Second, previous studies investigating differentiated learning and numeracy often involve limited research settings, small sample sizes, or pre-experimental designs that restrict the generalizability of findings (Indrawatiningsih et al., 2024). Third, systematic literature reviews discussing numeracy strategies within the Merdeka Curriculum mainly identify general instructional approaches such as game-based learning, manipulatives, visual media, and parental involvement without deeply examining differentiated instructional implementation in numeracy classrooms (Mustika et al., 2025).

Another important research gap concerns the practical implementation of diagnostic assessment and differentiated learning in Indonesian schools. Kholid et al. (2024) stated that differentiated instruction practices remain underexplored in Indonesian educational settings, particularly in mathematics and numeracy learning. Existing studies discussing diagnostic assessment and differentiated learning are often conducted in language learning contexts rather than mathematics classrooms. As a result, empirical evidence regarding how teachers implement differentiated numeracy instruction in the Merdeka Curriculum remains limited. Furthermore, there is still insufficient understanding regarding how differentiated learning affects students with different readiness levels, interests, and learning profiles in numeracy classrooms. This gap is important because differentiated learning fundamentally aims to accommodate classroom diversity and optimize students' individual potential.

The novelty of this study lies in its specific focus on the implementation of differentiated learning to improve students' numeracy skills within the framework of the Merdeka Curriculum. Unlike previous studies that mainly investigated general differentiated instruction practices or broader literacy outcomes, this research specifically examines differentiated numeracy learning in elementary education settings. This study also integrates diagnostic assessment practices as the basis for instructional differentiation, thereby providing a more comprehensive understanding of how differentiated learning can be systematically implemented in numeracy classrooms. Moreover, the study contributes to the growing literature on student-centered learning approaches in Indonesia by exploring how differentiated instruction aligns with the principles of the Merdeka Curriculum and supports numeracy competency development.

Based on these considerations, this study aims to analyze the implementation of differentiated learning in improving students' numeracy skills within the context of the Merdeka Curriculum. The findings of this study are expected to contribute theoretically to the development of differentiated instruction literature and practically to provide insights for teachers, schools, and policymakers regarding effective numeracy learning strategies in Indonesian elementary education. Through differentiated learning practices that accommodate students' diverse characteristics, numeracy learning is expected to become more meaningful, inclusive, and capable of supporting students' mathematical competency development in the era of educational transformation.

2. LITERATURE REVIEW

Numeracy Skills in Elementary Education

Numeracy skills are fundamental competencies that enable students to understand, interpret, and apply mathematical concepts in various real-life situations. In elementary education, numeracy is not limited to arithmetic calculation but also includes reasoning, problem-solving, data interpretation, and decision-making abilities. Numeracy competency is considered essential because it supports students' academic achievement and daily life problem-solving skills. However, many studies reported that elementary school students in Indonesia still demonstrate relatively low numeracy performance due to ineffective instructional approaches, limited contextual learning experiences, and low student engagement during mathematics learning activities. Teacher-centered learning practices often reduce students' opportunities to actively explore mathematical concepts and construct understanding independently, resulting in weak numeracy development (Mustika et al., 2025; Pudjastuti et al., 2024).

Several researchers also emphasized that low numeracy achievement is closely related to the lack of contextual and meaningful learning experiences. Students frequently perceive mathematics as abstract and disconnected from their daily lives, causing difficulties in understanding mathematical applications in authentic situations. Wahyudi et al. (2025) and Lubis et al. (2025) explained that contextual learning approaches significantly support numeracy improvement because students can connect mathematical concepts with real-world experiences. In addition, limited learning media, inadequate teacher competencies, and minimal classroom interaction further contribute to students' weak numeracy abilities. Therefore, improving numeracy requires innovative, student-centered, and adaptive instructional strategies that actively involve students in the learning process (Setiawan et al., 2024; Larasati et al., 2025).

Differentiated Learning in the Merdeka Curriculum

Differentiated learning is one of the core instructional approaches emphasized in the Merdeka Curriculum to accommodate students' diverse learning characteristics. This approach recognizes that students possess different readiness levels, learning profiles, interests, and abilities; therefore, instruction should be adjusted to meet these differences. Differentiated instruction involves modifications in learning content, learning processes, learning products, and classroom environments to ensure that all students can access meaningful learning experiences according to their individual needs. Noviyanti et al. (2025) explained that differentiated learning reflects the student-centered philosophy of the Merdeka Curriculum, which encourages flexibility, autonomy, and personalized learning pathways for students.

The implementation of differentiated learning also relies heavily on diagnostic assessment practices. Teachers use diagnostic assessments to identify students' prior knowledge, readiness levels, strengths, and learning difficulties before designing instructional activities. Kholid et al. (2024) reported that teachers implementing differentiated instruction commonly utilize digital platforms, questionnaires, and formative assessments to map students' learning characteristics. Based on the assessment results, teachers organize flexible grouping and provide varied learning tasks with different complexity levels. This adaptive instructional design allows students to learn more effectively according to their capacities while simultaneously increasing their motivation and engagement during classroom activities (Dinana et al., 2024; Indrawatiningsih et al., 2024).

The Effectiveness of Differentiated Learning on Numeracy Skills

Several previous studies demonstrated that differentiated learning positively affects students' numeracy competencies and mathematics learning outcomes. Indrawatiningsih et al. (2024) found that differentiated instruction significantly improved elementary school students' literacy and numeracy achievement, with a moderate N-gain score of 0.58. The study revealed that differentiated activities enabled students to better understand mathematical concepts because learning tasks were adjusted according to students' readiness levels and learning preferences. Similarly, Rosita et al. (2025) explained that integrating Problem-Based Learning with differentiated instruction significantly enhanced students' numeracy literacy and mathematical problem-solving abilities.

Differentiated learning contributes to numeracy improvement because it creates more flexible and inclusive learning experiences. Students are provided with opportunities to learn using various methods, media, and levels of task complexity that suit their abilities. As a result, students become more actively engaged in mathematical exploration and collaborative problem-solving activities. Moreover, differentiated instruction encourages students to participate confidently because learning activities feel more achievable and meaningful. This condition supports students' motivation, critical thinking, and conceptual understanding during numeracy learning (Indrawatiningsih et al., 2024; Rosita et al., 2025).

Student-Centered Approaches for Numeracy Development

Student-centered learning approaches have become increasingly important in mathematics education because they actively involve students in constructing knowledge and solving contextual problems. One of the widely implemented approaches is Realistic Mathematics Education (RME), which emphasizes contextual learning and authentic mathematical experiences. Fauzan et al. (2024) found that RME effectively improved students' numeracy and mathematical literacy because students learned mathematics through real-world problem-solving situations. Through contextual exploration, students were able to connect mathematical concepts with everyday experiences, making learning more meaningful and engaging.

Problem-Based Learning (PBL) also demonstrated significant effectiveness in improving students' numeracy competencies. In PBL, students are encouraged to solve authentic problems collaboratively, thereby promoting critical thinking, reasoning, and mathematical communication skills. Rahmah et al. (2023) and Pudjastuti et al. (2024) reported that PBL significantly enhanced elementary students' numeracy literacy because students actively participated in analyzing problems, discussing solutions, and presenting their reasoning. Additionally, ethnomathematics and contextual learning approaches were found to improve numeracy achievement by integrating local culture and students' daily experiences into mathematics instruction. These approaches share similar principles with differentiated learning because they prioritize flexibility, contextualization, and active student participation in learning activities (Larasati et al., 2025; Lubis et al., 2025).

3. METHOD

This study employed a quantitative approach using a quasi-experimental design to analyze the effectiveness of differentiated learning in improving students' numeracy skills within the framework of the Merdeka Curriculum. The research was conducted at an elementary school implementing the Merdeka Curriculum, involving two groups of fifth-grade students consisting of

an experimental class and a control class. The experimental class received differentiated learning instruction, while the control class was taught using conventional learning methods. Differentiated learning was implemented by adjusting learning content, learning processes, assignments, and classroom activities based on students' readiness levels, interests, and learning profiles identified through diagnostic assessment. The study was conducted over six weeks during mathematics learning activities focused on numeracy competencies such as problem-solving, mathematical reasoning, data interpretation, and contextual mathematical application. The population of the study consisted of all fifth-grade students, while the sample was selected using purposive sampling techniques according to classroom characteristics and curriculum implementation readiness.

Data collection techniques included numeracy tests, classroom observations, questionnaires, and documentation. Pre-tests and post-tests were administered to measure students' numeracy skill improvement before and after the implementation of differentiated learning. The numeracy test instrument consisted of contextual mathematical problems designed according to numeracy competency indicators in the Merdeka Curriculum. Classroom observations were conducted to examine students' participation, engagement, and learning interaction during differentiated instruction activities. Questionnaires were distributed to identify students' learning interests and responses toward differentiated learning implementation. Meanwhile, documentation techniques were used to collect supporting data related to lesson plans, diagnostic assessment results, and students' learning products. Data analysis was conducted quantitatively using descriptive and inferential statistical techniques. Descriptive analysis was used to present the mean, percentage, and standard deviation of students' numeracy achievement, while inferential analysis involved normality tests, homogeneity tests, paired sample t-tests, and independent sample t-tests to determine the significance of differences between the experimental and control groups. In addition, N-gain analysis was applied to measure the level of students' numeracy improvement after the differentiated learning intervention.

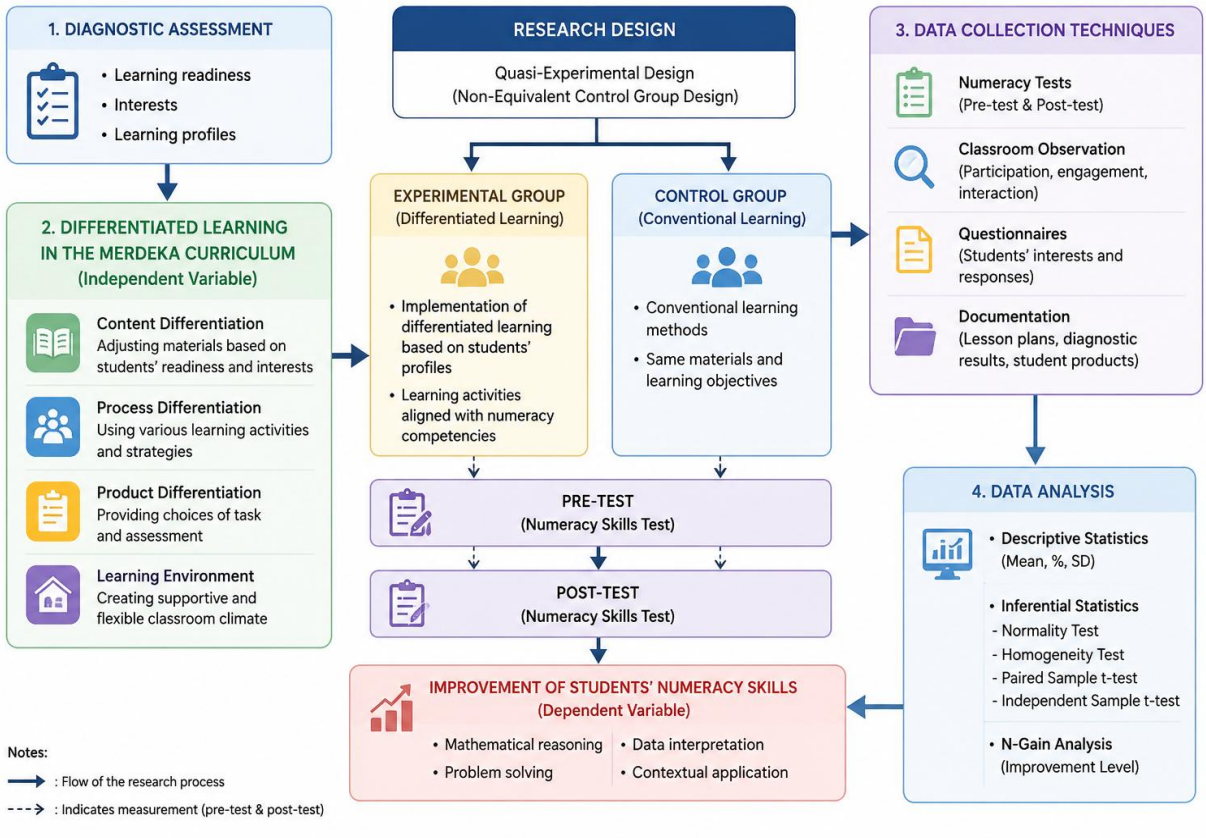

Figure 1. Diagram Conceptual Research

4. RESULTS AND DISCUSSION

The results of this study were obtained from the comparison of students' numeracy skill scores before and after the implementation of differentiated learning in the Merdeka Curriculum. The data analysis included descriptive statistics and inferential statistical testing to determine the effectiveness of differentiated learning compared to conventional learning methods.

Table 1. Results of Students' Numeracy Skills Analysis in Experimental and Control Groups

Variable	Experimental Group	Control Group	Sig. Value	Interpretation
Number of Students (N)	30	30	—	Sample size
Pre-Test Mean Score	61.20	60.45	—	Initial numeracy ability relatively similar
Post-Test Mean Score	84.35	71.10	—	Experimental group achieved higher scores
Gain Score	23.15	10.65	—	Experimental group improvement higher
N-Gain Category	High	Moderate	—	Differentiated learning more effective
Normality Test	Normal	Normal	0.200	Data normally distributed
Homogeneity Test	Homogeneous	Homogeneous	0.317	Variance homogeneous
Paired Sample t-Test	Significant	Significant	0.000	Significant pre-post improvement
Independent Sample t-Test	Higher Improvement	Lower Improvement	0.001	Significant difference between groups

Based on Table 1, the findings indicate that students who learned through differentiated learning achieved significantly better numeracy outcomes than students taught using conventional instruction. The experimental group showed a substantial increase in post-test scores, with a high N-gain category, while the control group only reached a moderate level of improvement. The inferential statistical tests also confirmed that the differences were statistically significant, as indicated by the significance values below 0.05. These results demonstrate that differentiated learning effectively improves students' numeracy skills by accommodating students' readiness, interests, and learning profiles in accordance with the principles of the Merdeka Curriculum.

Discussion

The findings of this study demonstrate that the implementation of differentiated learning within the Merdeka Curriculum significantly improved elementary school students' numeracy skills compared to conventional learning approaches. The quantitative results presented in Table 1 indicate that the experimental group experienced a considerable increase in numeracy achievement, with the post-test mean score rising from 61.20 to 84.35 and producing a high N-gain category. In contrast, the control group only achieved a moderate increase, with post-test scores rising from 60.45 to 71.10. These findings confirm that differentiated learning provides a more effective instructional approach for strengthening students' mathematical reasoning, contextual problem-solving, and numeracy understanding. The significance value obtained from the independent

sample t-test (0.001 < 0.05) further supports the conclusion that differentiated learning contributes substantially to numeracy improvement within the framework of the Merdeka Curriculum. This result aligns with the primary objective of the Merdeka Curriculum, which emphasizes flexible, student-centered learning and the principle of "teaching at the right level" to address diverse student needs and low numeracy achievement (Hidayah et al., 2024).

The improvement in students' numeracy performance can be understood through the instructional characteristics of differentiated learning implemented during the study. In the experimental class, students received learning materials, activities, and assessments adjusted to their readiness levels, interests, and learning profiles. This instructional flexibility enabled students to engage more actively in the learning process and reduced the learning barriers commonly experienced in conventional mathematics classrooms. The findings support previous studies explaining that differentiated learning enhances mathematical understanding because students receive learning experiences appropriate to their cognitive abilities and learning needs (Noviyanti et al., 2025; Ringo, 2025). In many Indonesian elementary schools, mathematics instruction is still dominated by teacher-centered approaches that focus heavily on procedural exercises rather than conceptual understanding and contextual numeracy application. Such practices often cause students to become passive, less motivated, and unable to connect mathematical concepts with real-life situations (Pudjastuti et al., 2024). The differentiated learning model implemented in this study attempted to overcome these limitations by creating flexible learning pathways and encouraging active student participation.

The significant increase in post-test scores in the experimental group also reflects the effectiveness of diagnostic assessment as an essential component of differentiated learning. Before the intervention, students' readiness levels and learning profiles were identified through initial assessments, enabling teachers to design learning activities that matched students' abilities. This finding supports Samsudi et al. (2024), who emphasized that diagnostic assessment plays a crucial role in ensuring successful differentiated learning implementation because it helps teachers recognize students' academic strengths and weaknesses. Similarly, Faigawati et al. (2023) argued that differentiated instruction cannot function effectively without careful identification of student characteristics and learning needs. In this study, diagnostic assessment allowed teachers to classify students into flexible learning groups and provide different levels of mathematical tasks according to students' numeracy competencies. Consequently, students who previously struggled with basic numeracy concepts were able to receive additional guidance and scaffolding, while higher-achieving students were challenged with more complex contextual mathematical problems.

The results also demonstrate that differentiated learning effectively supports the principles of student-centered learning promoted in the Merdeka Curriculum. The implementation of differentiated content, process, and product created a classroom atmosphere where students actively explored mathematical concepts rather than merely memorizing formulas. During the intervention, students engaged in contextual problem-solving activities, collaborative discussions, and flexible assignments designed according to their learning preferences. These findings are consistent with Caesaria et al. (2024), who found that differentiated learning improves the quality of mathematics instruction through varied learning activities and adaptive teaching strategies. Likewise, Faigawati et al. (2023) reported that differentiated instruction encourages greater student participation because learning activities become more meaningful and relevant to students' experiences. In the context of numeracy learning, contextual and interactive activities are essential because numeracy requires students not only to calculate but also to interpret information, analyze situations, and apply mathematical reasoning in daily life contexts.

Another important finding of this study relates to the improvement of students' mathematical communication and problem-solving abilities as part of numeracy competence. Students in the experimental group demonstrated greater confidence in explaining mathematical solutions, interpreting data, and presenting their reasoning compared to students in the control group. This result is highly relevant because numeracy competence involves the ability to communicate mathematical ideas clearly and apply mathematical reasoning in practical situations. The findings support Frildawati et al. (2024), who found that differentiated learning significantly improves students' mathematical communication skills. According to the study, flexible learning

pathways and varied problem-solving activities allow students to express mathematical understanding in multiple forms, including oral explanations, written solutions, and collaborative presentations. Similarly, Noviyanti et al. (2025) argued that differentiated learning strengthens higher-order thinking skills because students are encouraged to engage in analytical and reflective learning processes.

The high N-gain category achieved by the experimental group indicates that differentiated learning not only improved students' immediate academic performance but also contributed to meaningful learning development. Students became more capable of solving contextual mathematical problems involving reasoning, interpretation, and decision-making processes. This finding is particularly important because numeracy competence in the Merdeka Curriculum is closely associated with the development of real-life problem-solving abilities. Previous studies have shown that contextual learning approaches such as Realistic Mathematics Education (RME), Problem-Based Learning (PBL), and ethnomathematics are effective in improving students' numeracy because they connect mathematical concepts with authentic experiences (Fauzan et al., 2024; Rahmah et al., 2023; Larasati et al., 2025). Differentiated learning complements these approaches by ensuring that contextual tasks are adapted to students' varying levels of understanding and readiness. As a result, students can participate in meaningful mathematical exploration without experiencing excessive cognitive overload or frustration.

The findings also reveal that differentiated learning helps reduce disparities among students with different academic abilities. In conventional classrooms, students with lower numeracy skills often struggle to follow instruction because learning materials are presented uniformly regardless of students' readiness levels. Conversely, higher-achieving students may become disengaged because instructional tasks are insufficiently challenging. In this study, differentiated instruction addressed these issues by providing tiered assignments and flexible learning support. This result aligns with Herlina (2023), who identified significant diversity in students' mathematical understanding, learning styles, and academic readiness in elementary school classrooms implementing the Merdeka Curriculum. Herlina emphasized that differentiated learning strategies such as heterogeneous grouping, varied media, and adaptive assignments are necessary to accommodate student diversity and improve mathematics achievement. The present study confirms these arguments by demonstrating that differentiated learning creates a more inclusive mathematics classroom where students can progress according to their abilities.

The implementation of differentiated learning in this study also contributed positively to students' learning motivation and classroom engagement. During the intervention, students showed greater enthusiasm in participating in mathematical discussions and solving contextual problems. This finding is significant because low motivation is frequently associated with poor numeracy achievement in Indonesian elementary schools (Mustika et al., 2025). Student-centered learning environments that allow flexibility, choice, and collaboration can increase students' sense of ownership over the learning process. Noviyanti et al. (2025) explained that differentiated learning improves motivation because students feel that learning activities are aligned with their capabilities and interests. Similarly, Dinana et al. (2024) emphasized that the Merdeka Curriculum encourages active student involvement and independent learning, both of which are supported by differentiated instructional strategies.

Despite the positive findings, the study also identified several challenges in implementing differentiated learning effectively. One of the primary challenges involved the teacher's workload in preparing varied instructional materials, assessments, and learning activities. Designing differentiated tasks for students with different readiness levels required considerable planning time and instructional creativity. This finding supports previous studies indicating that teachers often experience difficulties implementing differentiated learning due to limited time, large class sizes, and insufficient instructional resources (Digna et al., 2023; Fitriyah & Turmudzi, 2025). Furthermore, some teachers still lack comprehensive understanding of differentiated instruction principles and practical implementation strategies. Witraguna et al. (2024) reported that many elementary school teachers in Indonesia remain unfamiliar with systematic differentiated learning practices, particularly in mathematics and numeracy instruction. Therefore, professional

development programs and continuous mentoring are essential to strengthen teachers' competencies in designing adaptive learning environments.

Teacher readiness and pedagogical competence emerged as critical factors influencing the success of differentiated learning implementation. During the intervention, the teacher's ability to manage flexible grouping, provide individualized support, and facilitate contextual discussions significantly affected classroom dynamics and student participation. Muqtada et al. (2025) found that teacher training programs focusing on differentiated instruction improve teachers' pedagogical skills and positively influence student engagement and academic performance. Similarly, Agusdianita et al. (2025) emphasized that sustained mentoring and collaborative teacher reflection are necessary for successful implementation of differentiated learning in the Merdeka Curriculum. The findings of this study reinforce the importance of strengthening teacher capacity through workshops, collaborative learning communities, and instructional supervision focused on differentiated pedagogy.

This study also contributes to addressing an important research gap related to numeracy learning in the Merdeka Curriculum. Previous studies on differentiated learning in Indonesia have predominantly focused on general mathematics achievement, critical thinking, or problem-solving skills rather than numeracy as a distinct educational outcome (Ringo, 2025). Moreover, many studies concerning numeracy within the Merdeka Curriculum have emphasized policy analysis, national assessment programs, or teacher perceptions rather than classroom-based instructional interventions (Khomaria & Jupri, 2024; Hidayah et al., 2024). By employing a quasi-experimental design and explicitly measuring numeracy competencies such as contextual reasoning, mathematical interpretation, and problem-solving, this study provides empirical evidence regarding the effectiveness of differentiated learning for improving numeracy skills in elementary school students.

The findings further suggest that differentiated learning has the potential to become an important instructional strategy for strengthening numeracy education in Indonesian elementary schools implementing the Merdeka Curriculum. The integration of differentiated content, adaptive learning processes, flexible assessment products, and supportive learning environments enables students to develop numeracy competencies more effectively and meaningfully. These results align with the broader educational goals of the Merdeka Curriculum, which seeks to create equitable, student-centered, and competency-based learning experiences. Future studies are recommended to explore the long-term effects of differentiated learning on numeracy development, examine its implementation across different grade levels and school contexts, and investigate its interaction with other innovative learning models such as Problem-Based Learning, Project-Based Learning, and digital learning technologies.

5. CONCLUSION

The findings of this study indicate that the implementation of differentiated learning within the Merdeka Curriculum has a positive and significant impact on improving elementary school students' numeracy skills. Through differentiated strategies in content, process, product, and learning environment, students were able to engage more actively in contextual mathematical learning activities that matched their readiness levels, interests, and learning profiles. The study findings also demonstrate that differentiated learning supports the principles of student-centered learning promoted by the Merdeka Curriculum, particularly in fostering problem-solving abilities, mathematical reasoning, and contextual numeracy competencies. Students with varying initial abilities showed meaningful improvement because the learning activities provided flexible instruction and appropriate scaffolding based on their individual needs. In addition, diagnostic assessment, heterogeneous grouping, and adaptive learning materials contributed to increased student participation, confidence, and learning motivation in numeracy instruction. However, the effectiveness of differentiated learning was also influenced by teachers' pedagogical competence, instructional planning, and the availability of learning resources. Therefore, differentiated learning can be considered an effective instructional approach for strengthening numeracy achievement in

elementary schools under the implementation of the Merdeka Curriculum, while continuous teacher training and institutional support remain essential for sustainable implementation.

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