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The Implementation of Differentiated Instruction in Mathematics to Address Differences in Cognitive Styles Among Students at SMP Negeri 1 Batang Kuis

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Abstract
This study aims to improve students' mathematics learning outcomes and address differences in students' cognitive styles through the implementation of differentiated instruction at SMP Negeri 1 Batang Kuis. This research employed a Classroom Action Research (CAR) design using the Kemmis and McTaggart model, which was conducted in two cycles. Each cycle consisted of planning, action, observation, and reflection stages. The subjects of this study were 32 seventh-grade students, consisting of 16 male and 16 female students. Data were collected through observation, interviews, learning outcome tests, and documentation. The results showed that differentiated instruction improved students' learning activities and mathematics achievement. Students' learning activities increased from 78.13% in the first cycle to 90.63% in the second cycle. Meanwhile, the percentage of students achieving mastery learning increased from 46.88% in the pre-cycle condition to 68.75% in the first cycle and 90.63% in the second cycle. These findings indicate that differentiated instruction, implemented through tiered worksheets, varied learning media, group discussion, and individual guidance, was effective in accommodating students' cognitive style differences. Therefore, differentiated instruction is recommended as an alternative strategy to create more inclusive, adaptive, and student-centered mathematics learning.
Keywords: differentiated instruction; mathematics learning; cognitive style; classroom action research; learning outcomes

1. INTRODUCTION

Mathematics education plays a crucial role in developing students' logical, analytical, systematic, critical, and creative thinking skills (Ichsan et al., 2024). Through mathematics instruction, students are not only guided to master concepts and procedures but are also trained to solve problems in a structured manner and make decisions based on rational reasoning (Duma et al., 2024). Therefore, mathematics instruction must be designed meaningfully to optimally develop each student's cognitive potential (Sari & Kowiyah, 2024).

Nevertheless, mathematics teaching practices in the classroom often do not fully account for students' individual differences. Teachers tend to present material, assign exercises, and conduct assessments in a uniform manner for all students. In reality, each student has different levels of prior knowledge, interests, motivation, cultural backgrounds, and learning styles. This situation can lead some students to find the lessons too difficult, while others find them not challenging enough (Aprima & Sari, 2022).

Differences in cognitive styles are one of the key factors influencing how students process, organize, and use information when learning mathematics. Students with certain cognitive styles may be more comfortable learning through visualization, while others may learn more effectively through verbal

activities, hands-on manipulation, or abstract reasoning (Ocsis et al., 2024). If learning strategies do not align with students' cognitive characteristics, the learning process may become less effective, and mathematics learning outcomes may not be optimal (Filma et al., 2025).

This issue highlights the need for mathematics instruction to shift from a one-size-fits-all approach to one that is responsive to students' needs (Karimah et al., 2024). It is not enough for teachers to simply master the subject matter; they must also be able to recognize student diversity and provide learning experiences tailored to students' learning profiles. In this context, differentiated instruction emerges as a relevant alternative strategy to implement (Putri, 2024).

Differentiated instruction is a teaching approach that focuses on meeting students' learning needs based on their readiness level, interests, learning styles, and existing skills. This approach tailors teaching methods, materials, and strategies to each student's unique characteristics, making learning more relevant and meaningful. As stated by Aprima and Sari (2022), differentiated instruction is an approach that adapts teaching to the individual learning needs of students.

According to Tomlinson (2017), differentiated instruction can be implemented by modifying four main components: content, process, product, and learning environment. Content differentiation involves presenting material according to students' level of complexity and readiness; process differentiation involves varying teaching methods and learning activities; product differentiation involves the form of learning outcomes; and environmental differentiation involves creating a classroom atmosphere that supports student diversity (Tomlinson, 2017; Wang et al., 2025).

In mathematics instruction, differentiated instruction can be implemented through the provision of tiered worksheets, the use of visual and manipulative media, group discussions, problem-based learning, and the use of educational technology. Teachers can also provide guidance at varying levels of intensity depending on students' level of understanding. Thus, students who need reinforcement can receive more support, while students who have mastered the material can be provided with enrichment activities (Ismail et al., 2025; Sari & Kowiyah, 2024).

Differentiated instruction also plays a role in creating a more inclusive learning environment. Teachers who implement this approach strive to ensure that every student has an equal opportunity to develop, regardless of differences in their prior knowledge and backgrounds. Strategies such as tiered assignments, group learning, varied media, and flexible assessment can help students learn according to their needs (Kriza et al., 2024).

Several studies have shown that the implementation of differentiated instruction has a positive impact on student engagement and learning outcomes. In the teaching of three-dimensional shapes, the implementation of a differentiated instruction model was shown to increase student engagement and improve the mathematics learning outcomes of fifth-grade elementary school students (Sari & Kowiyah, 2024). These findings indicate that instruction tailored to students' needs can foster higher levels of engagement in learning.

A study by Filma et al. (2025) involving sixth-grade students at SD Negeri 060925 in Medan Amplas also showed that a differentiated approach which adapts instructional strategies to students' needs, interests, and readiness levels has a positive impact on the quality of mathematics instruction and learning outcomes. The average cognitive learning achievement of students increased from 74.93% in the first cycle to 81.56% in the second cycle (Filma et al., 2025). These results reinforce the argument that instruction responsive to student diversity can enhance the effectiveness of mathematics learning.

Based on this discussion, differences in students' cognitive styles should form the

basis for designing mathematics instruction. Teachers need to map learning needs through diagnostic assessments, design varied activities, provide guidance tailored to students' characteristics, and evaluate and reflect on the instruction that has been delivered. These steps align with the practice of differentiated instruction in the implementation of the Merdeka Curriculum for mathematics (Putri, 2024).

Therefore, a study titled "The Application of Differentiated Instruction in Mathematics to Address Differences in Students' Cognitive Styles" is important to conduct. This study is expected to provide insights into how teachers identify differences in students' cognitive styles, apply differentiation strategies in mathematics instruction, and evaluate their impact on student activities, conceptual understanding, and learning outcomes. Consequently, this study is expected to make theoretical and practical contributions to the development of mathematics instruction that is more adaptive, inclusive, and student-centered (Aprima & Sari, 2022; Filma et al., 2025; Sari & Kowiyah, 2024).

2. METHOD

This study employs the Classroom Action Research (CAR) approach. This approach was chosen because it aims to improve and enhance the quality of the mathematics learning process through the implementation of differentiated instruction to address differences in students' cognitive styles. CAR is a reflective research process conducted continuously by a teacher or researcher in collaboration with others to improve classroom teaching practices (Kemmis & McTaggart, 1988).

The CAR model used in this study is the Kemmis and McTaggart model. This model consists of four stages in each cycle: planning, acting, observing, and reflecting. These four stages are carried out sequentially and are interrelated to ensure that learning improvement actions are implemented systematically and can be evaluated objectively (Kemmis & McTaggart, 1988).

The subjects of this study were seventh-grade students at SMP Negeri 1 Batang Kuis during the odd semester of the 2025/2026 academic year. Subjects were selected using purposive sampling, specifically by choosing a class that exhibited significant differences in cognitive styles and a wide range of mathematics learning abilities. A total of 32 students participated in the study, consisting of 16 male students and 16 female students.

The data collection techniques used in this study included observation, interviews, tests, and documentation. Observations were conducted to gather data on teacher and student activities during differentiated instruction, including student engagement, participation, and responses to the strategies implemented. Interviews were used to elicit more in-depth information regarding learning difficulties, learning preferences, and students' perceptions of mathematics instruction.

Documentation was used to collect supporting data in the form of lesson plans, student worksheets, student work samples, photographs of learning activities, grade sheets, and teacher reflection notes. In addition, learning outcome tests were administered at the end of each cycle to measure improvements in students' understanding of mathematical concepts after participating in differentiated instruction. The simultaneous use of several data collection techniques was intended to obtain comprehensive data that reinforced one another.

The validity of the data in this study was tested using methodological triangulation and source triangulation. Methodological triangulation was conducted by comparing the results of observations, interviews, documentation, and learning outcome tests, while source triangulation was conducted by comparing data obtained from students, collaborating teachers, and the researcher. The collected data were analyzed using simple qualitative and quantitative descriptive methods. The

success of the study was determined by an increase in students' learning activities and mathematics learning outcomes from the first cycle to the second cycle.

3. RESULT AND DISCUSSION

Result

This study was conducted in two cycles using the Classroom Action Research (CAR) model developed by Kemmis and McTaggart. Each cycle consisted of the stages of planning, implementation, observation, and reflection. Before the intervention was implemented, a preliminary assessment was conducted to map the differences in students' cognitive styles and initial mathematics abilities. The results of the initial assessment showed that among the 32 seventh-grade students at SMP Negeri 1 Batang Kuis, there was a significant variation in ability, with only 15 students, or 46.88%, having achieved mastery of the material.

In the first cycle, the teacher implemented differentiated instruction based on the results of the diagnostic assessment. Differentiation was applied across three main aspects: content, process, and product. The teacher provided tiered worksheets, a variety of learning media, and group activities tailored to the students' characteristics and levels of understanding. Observation results showed that student engagement increased to 78.13%, and teacher engagement reached 84.38%. Meanwhile, test results indicated that 22 students, or 68.75%, had achieved learning mastery.

Although there was an improvement, the results of the first cycle did not yet meet the established success indicator, namely that at least 85% of students achieve learning mastery. Based on the reflection, there were still some students who had difficulty understanding the material, particularly when solving application problems. In addition, group management was not yet fully optimal because some students were still not active enough in discussions. Therefore, improvements were made in the second cycle, including strengthening individual guidance, using a wider variety of teaching materials, and forming heterogeneous groups.

In the second cycle, differentiated instruction was implemented using more structured strategies. The teacher provided tiered guidance tailored to students' needs, utilized visual and manipulative materials, and assigned tasks with varying levels of difficulty. Observation results showed an increase in student activity to 90.63% and teacher activity to 93.75%. The final test results for the second cycle showed that 29 students, or 90.63%, had achieved mastery of the material.

Based on these results, there was an increase in student learning achievement from 46.88% at the baseline to 68.75% in the first cycle, and then to 90.63% in the second cycle. An increase in student engagement was also clearly evident, rising from 78.13% in the first cycle to 90.63% in the second cycle. Thus, the research success indicators were met in the second cycle..

Discussion

The results of the study indicate that the implementation of differentiated instruction is effective in addressing differences in students' cognitive styles in mathematics learning. Through the differentiation of content, process, and products, students gain learning experiences tailored to their readiness levels, interests, and learning styles. This aligns with Tomlinson's (2017) concept, which states that differentiated instruction involves modifying content, process, products, and the learning environment to meet students' needs.

The increase in student activity during the second cycle indicates that students become more engaged in the learning process when the strategies used align with their learning characteristics. Students with a visual cognitive style benefit more from the use of images and diagrams, while students with a verbal cognitive style are more active in discussions and concept explanations. These findings demonstrate that varying instructional strategies can

foster more equitable engagement among students.

The improvement in learning outcomes from the first cycle to the second cycle also indicates that tiered instruction and tiered worksheets have a positive impact on students' understanding of mathematical concepts. Students who needed reinforcement received more intensive guidance, while students who had already mastered the material were provided with enrichment activities. This strategy helps each student develop according to their abilities without feeling left behind or underchallenged.

The findings of this study are consistent with previous research showing that differentiated instruction can improve students' mathematics learning outcomes. A study of fourth-grade students at SDN Rejomulyo showed an increase in learning achievement from 71.42% in the first cycle to 92.85% in the second cycle following the implementation of differentiated instruction (Sari & Kowiyah, 2024). Similar findings were also reported by Filma et al. (2025), who demonstrated an increase in mathematics learning achievement following the implementation of a differentiated approach.

Thus, it can be concluded that the implementation of differentiated instruction in mathematics is effective in addressing differences in students' cognitive styles at SMP Negeri 1 Batang Kuis. The increase in student activity and learning outcomes indicates that this approach is capable of creating a more inclusive, adaptive, and student-centered learning environment.

4. CONCLUSION

Based on the research findings and discussion, it can be concluded that the implementation of differentiated instruction in mathematics is effective in addressing differences in students' cognitive styles at SMP Negeri 1 Batang Kuis. Differentiated instruction was implemented through the differentiation of content, process, and products tailored to students' readiness levels, interests, and learning styles.

The research results show an increase in student learning activity from the first cycle to the second cycle. Student activity increased from 78.13% in the first cycle to 90.63% in the second cycle. This increase indicates that students became more engaged, active, and responsive when learning strategies aligned with their characteristics and learning needs.

The implementation of differentiated instruction also had a positive impact on students' mathematics learning outcomes. The mastery rate increased from 46.88% at the baseline to 68.75% in the first cycle, and then rose to 90.63% in the second cycle. Thus, the research success indicator—set at a minimum of 85%—was achieved in the second cycle.

This improvement indicates that the use of tiered worksheets, varied learning media, individual guidance, and the formation of heterogeneous groups helped students understand mathematical concepts according to their individual abilities. This strategy provided a more equitable opportunity for all students to develop, whether they needed remedial support or enrichment.

Thus, it can be concluded that differentiated instruction is an effective strategy for creating a more inclusive, adaptive, and student-centered mathematics learning experience. It is recommended that mathematics teachers continue to develop the application of this strategy in order to address the diversity of students' cognitive styles and learning abilities in the classroom.

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