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DIFFERENTIATED LEARNING STRATEGIES FOR ENHANCING ENGAGEMENT AND ACHIEVEMENT IN MATHEMATICS: A CLASSROOM ACTION RESEARCH STUDY

Deny Hadi Siswanto [a*], Arga Bagus Pratama Dyah Aan Firman Syah [b], Hary Kuswantara [c]
[a] Mathematics Teacher, denysiswanto11@guru.sma.belajar.id,
Muhammadiyah Mlati Senior High School, Sleman
[b] Mathematics Teacher, argasyah21@guru.smk.belajar.id,
Muhammadiyah 1 Sleman Vocational High School, Sleman
[c] Master of Mathematics Education, 2207050006@webmail.uad.ac.id,
Ahmad Dahlan University, Yogyakarta
[*] Correspondence

ABSTRACT

This study aims to enhance students' engagement and mathematics achievement through the implementation of differentiated learning. The method employed is classroom action research conducted in two cycles, each consisting of planning, action implementation, observation, evaluation, and reflection stages. The research was carried out during the odd semester at SMK Muhammadiyah 1 Sleman with the participation of 28 students from the XI Automotive class. The findings reveal a significant improvement in students' engagement and learning outcomes. In the first cycle, the average engagement score was 9.51, which increased to 17.12 in the second cycle. Regarding learning outcomes, in the first cycle, only 10 students (35,71%) achieved the passing grade, while 18 students (64.29%) did not, with an average score of 64.75. In the second cycle, the number of students achieving the passing grade sharply increased to 28 students (100%) with an average score of 84.92. These results demonstrate that differentiated learning effectively enhances student engagement and mathematics achievement in the XI Automotive class at SMK Muhammadiyah 1 Sleman during the 2024/2025 academic year.

Keywords: *differentiated learning, learning activities, learning outcomes, mathematics*.

Abstrak

Penelitian ini bertujuan untuk meningkatkan keterlibatan siswa dan pencapaian matematika melalui penerapan pembelajaran yang dibedakan. Metode yang digunakan adalah penelitian tindakan kelas yang dilakukan dalam dua siklus, masing-masing terdiri dari tahap perencanaan, pelaksanaan tindakan, observasi, evaluasi, dan refleksi. Penelitian ini dilaksanakan pada semester ganjil di SMK Muhammadiyah 1 Sleman dengan partisipasi 28 siswa dari kelas XI Otomotif. Hasil penelitian menunjukkan adanya peningkatan signifikan dalam keterlibatan siswa dan hasil belajar. Pada siklus pertama, skor rata-rata keterlibatan siswa adalah 9,51, yang meningkat menjadi 17,12 pada siklus kedua. Dalam hal hasil belajar, pada siklus pertama, hanya 10 siswa (35,71%) yang mencapai nilai kelulusan, sementara 18 siswa (64,29%) tidak, dengan rata-rata nilai 64,75. Pada siklus kedua, jumlah siswa yang mencapai nilai kelulusan meningkat tajam menjadi 28 siswa (100%) dengan rata-rata nilai 84,92. Hasil ini menunjukkan bahwa pembelajaran yang dibedakan secara efektif dapat meningkatkan keterlibatan siswa dan pencapaian matematika di kelas XI Otomotif di SMK Muhammadiyah 1 Sleman selama tahun ajaran 2024/2025.

Kata Kunci: pembelajaran berdifferensiasi, aktivitas pembelajaran, hasil belajar, matematika.

1. INTRODUCTION

Learning is the core of the educational process, aimed at creating a generation that is intelligent, creative, and competitive [1]. In the context of vocational education, such as in SMK Muhammadiyah 1 Sleman, learning

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not only focuses on enhancing theoretical knowledge but also equips students with practical skills aligned with their areas of expertise. Vocational education emphasizes the provision of skills relevant to workforce demands [2]. One of the main challenges in this process is implementing teaching methods that accommodate the diversity of students' abilities, learning styles, and potential. This becomes increasingly critical in subjects like mathematics, which is often perceived as difficult by many students [3],[4].

In the Grade XI Automotive class at SMK Muhammadiyah 1 Sleman, notable differences exist in students' abilities to grasp mathematical concepts. Some students excel and quickly solve problems, while others require additional time and guidance to understand basic concepts. If not addressed properly, such differences can lower student motivation, hinder learning activities, and negatively affect overall learning outcomes. Teachers are thus required to design teaching strategies that bridge these gaps to ensure effective learning for all students [5].

A relevant approach to addressing this challenge is differentiated learning. This approach is designed to meet the individual learning needs of students by adjusting the content, process, and learning products based on their abilities, interests, and learning styles [6]. In mathematics education, this strategy is highly suitable, as the subject often requires flexible approaches to accommodate varying levels of understanding, especially in abstract topics such as algebra, geometry, and trigonometry.

Research findings Wakhata et al. [7] indicate that differentiated learning can significantly increase student engagement in the learning process. Students actively involved in learning are more motivated and show substantial improvement in their learning outcomes. This approach also helps students develop critical and creative thinking skills, which are essential for solving mathematical problems [8],[9]. These benefits make differentiated learning a promising strategy for improving educational quality, particularly in mathematics education at vocational high schools.

At SMK Muhammadiyah 1 Sleman, especially in the Grade XI Automotive class, mathematics lessons often face challenges related to low student interest in active participation. This is due to factors such as the perceived irrelevance of mathematics to the automotive field or unengaging teaching methods. Teachers are encouraged to connect mathematics concepts to the automotive world, making learning more meaningful and relevant to students' interests [10],[11].

One way to overcome these challenges is by integrating differentiated learning relevant to the vocational context [12]. For example, geometry concepts can be taught by linking them to the design of vehicle components commonly used in the automotive field. Practical examples, such as measuring angles in a vehicle suspension system or calculating the surface area of engine parts, provide tangible illustrations of mathematics in automotive applications. Additionally, algebraic concepts can be applied to mechanical calculations, such as determining gear ratios or fuel efficiency. Through this approach, students not only learn theoretical mathematics but also understand its practical benefits in everyday life and their chosen field of expertise, significantly boosting their interest in mathematics [13]–[15].

The success of differentiated learning heavily relies on the active role of teachers as facilitators. Teachers are not merely transmitters of information but also act as bridges between learning materials and students' individual needs [16], [17]. Teachers must thoroughly understand the needs, learning styles, and potential of each student through observation, discussions, or preliminary assessments. This understanding enables teachers to design relevant and meaningful learning activities [18]. For instance, using simulations of mechanical calculations or videos demonstrating geometric measurements in automotive contexts can effectively connect abstract concepts to practical applications [19].

Implementing differentiated learning requires careful planning to achieve optimal results [20]. The planning process begins with an initial analysis of students' needs, including their skill levels, interests, and learning preferences [21]. Based on this analysis, teachers can design varied learning activities, such as small group discussions for students with foundational skills or individual projects for advanced learners. Teachers must continuously monitor the implementation of these strategies to ensure their effectiveness and evaluate the approach's impact. Additionally, involving students in providing feedback is crucial for improving the quality of learning.

In the context of mathematics education at SMK Muhammadiyah 1 Sleman, implementing differentiated learning is a strategic step in addressing existing challenges. By linking mathematics learning to the automotive field, which is more relatable to students, this approach not only simplifies the understanding of mathematical concepts but also helps students appreciate the relevance of mathematics in real life [22], [23]. This is important for building students' confidence in mastering material they previously found difficult. By actively participating in learning, students are also expected to develop critical thinking, problem-solving, and collaboration skills that are essential in the workplace.

Based on this background, this study aims to explore the effectiveness of differentiated learning in addressing diverse learning challenges, both in terms of students' abilities and specific vocational contexts. The findings of this research are expected to contribute significantly to improving the quality of mathematics education at vocational high schools and serve as a reference for educators in other vocational institutions in designing innovative, relevant, and inclusive teaching strategies.

2. LITERATURE REVIEW

2.1. Differentiated Learning

Differentiated instruction is a pedagogical approach designed to address the diverse learning needs of students within a single classroom. Ramadhani et al. [24] explains that differentiated instruction involves adjusting the content, process, product, or learning environment based on students' abilities, interests, and learning profiles. This approach aims to ensure that each student experiences meaningful learning tailored to their level of understanding [25]. In the context of modern education, differentiated instruction offers a solution to the challenges posed by student heterogeneity, such as differences in learning styles, cognitive abilities, and interests. Research by Fauzi et al. [26] indicates that the implementation of differentiated instruction can enhance students' learning motivation, engagement, and overall academic achievement.

The implementation of differentiated instruction requires careful planning and the ability of teachers to understand the individual needs of their students. Teachers must effectively manage heterogeneous classrooms by creating varied learning strategies, such as assigning tasks suited to students' levels of ability or employing diverse teaching media. According to Puspitasari et al. [27] and Tarso et al. [28], differentiated instruction strategies involve a combination of small group approaches, independent learning, and whole-class discussions to accommodate diverse learning needs.

While effective, the primary challenges in implementing differentiated instruction include time constraints for teachers to design lessons, limited resources, and the need for specialized training for educators. However, with proper planning and institutional support, differentiated instruction can become an effective approach for improving the quality of education, particularly in inclusive and vocational education settings.

2.2. Mathematics Learning Outcomes

Mathematics learning outcomes are the achievements students gain after participating in the learning process, encompassing cognitive, affective, and psychomotor aspects. According to Nirfayanti et al. [29], learning outcomes involve three main domains: knowledge (cognitive), attitudes (affective), and skills (psychomotor). In mathematics education, learning outcomes are often measured by students' ability to understand concepts, apply theories, and solve problems. As an abstract subject, mathematics requires appropriate teaching strategies to help students internalize the concepts being taught [30], [31]. Research indicates that interactive and contextual teaching approaches can enhance students' understanding of mathematical materials. Good learning outcomes are also strongly influenced by students' ability to think critically, creatively, and analytically.

Mathematics learning outcomes are influenced by various internal and external factors. Internal factors include cognitive ability, interest, learning motivation, and students' attitudes toward mathematics. Meanwhile, external factors encompass the quality of teaching, availability of learning resources, learning environment, and family support. According to Novantoro et al. [32] and Wantoro et al. [33], one of the main determinants of students' success in mathematics is the effectiveness of the teaching strategies employed by teachers. Additionally, innovative teaching methods, such as problem-based learning and differentiated instruction, significantly contribute to improving learning outcomes. A common challenge in mathematics education is the perception that mathematics is difficult and irrelevant to daily life [34]. Therefore, teachers are required to create meaningful, relevant, and engaging learning experiences to help students achieve optimal learning outcomes.

3. METHOD

This research is a Classroom Action Research (CAR) that consists of four main stages: planning, implementation, observation, and reflection. Each research cycle begins with careful and detailed planning, which includes three main activities: problem identification, problem formulation, and solution development. Each activity involves sub-steps designed to ensure optimal planning. The implementation stage involves executing the planned actions in the classroom. Next, the observation stage aims to record the extent to which the actions taken have achieved the desired goals. In this stage, the researcher identifies the types of data to be collected, collection methods, and tools used, such as tests, questionnaires, or observation sheets. Finally, the reflection stage reviews the entire process to identify the successes, weaknesses, or shortcomings of the actions taken [35].

The data collection techniques used include observations and learning outcome tests. Observations are conducted to systematically record student activities during the learning process, complementing quantitative data with notes on observation sheets. Learning outcome tests are employed to evaluate student achievements, such as in the XI Automotive class, by referencing the minimum mastery criterion of 70, using a post-test. Quantitative data is obtained through learning outcome tests, while qualitative data is collected from observations. All data is analyzed through data reduction, data presentation, and conclusion drawing to provide a comprehensive depiction of the results. The n-Gain test, as derived from Hake [36], is also used to measure the improvement in students' learning outcomes.

4. RESULTS AND DISCUSSION

4.1 Results of Cycle I

Student learning activity data in the learning process was analyzed using descriptive methods. Grouping of activities was carried out by referring to the ideal mean (MI) and ideal standard deviation (SDI) as follows.

Table 1. Criteria for student learning activity

Range	Criteria
$\bar{M} \geq 17.2$	Very Active
$13.4 \leq \bar{M} < 17.2$	Active
$9.6 \leq \bar{M} < 13.4$	Quite Active
$5.8 \leq \bar{M} < 9.6$	Less Active
$\bar{M} < 5.8$	Very Less Active

Observation of student learning activities in Cycle I was conducted over two learning sessions, which included two meetings. During the first meeting, it was recorded that 28 students were present. Similarly, in the second meeting, student attendance remained consistent at 28 students. This full attendance reflects the students' enthusiasm for participating in the learning process. Based on the observation results, the average score for student learning activities during Cycle I was recorded at 9.51. When compared to the predetermined criteria, this score indicates that the level of student learning activity in Cycle I falls under the category of fairly active. This suggests a reasonably good level of participation from students, although there is still room for improvement in subsequent cycles. Meanwhile, the data on student learning outcomes is presented in table 2 below.

Table 2. Descriptive Statistics of Cycle I

Descriptive Statistics

	N	Range	Minimum	Maximum	Sum	Mean	Std. Deviation	Variance
Cycle I	28	32.00	48.00	80.00	1813.00	64.7500	7.18344	51.602

Based on the table above, the descriptive statistics for Cycle I show that there were 28 participants, with a range of 32 points, from a minimum score of 48 to a maximum score of 80. The total number of scores was 1813, with an average score of 64.75. The standard deviation was 7.18, indicating a variation in scores, and the variance was 51.60, reflecting the spread of data around the average.

4.2. Results of Cycle II

At the first meeting, there were 28 students present, and the same number also attended the second meeting. This shows the consistency of student attendance levels during the two meetings. Based on the data obtained, the average score of student learning activities in cycle II was recorded at 17.12. With this value, it can be concluded that the level of student learning activities in cycle II is classified as active, reflecting quite high student involvement in learning activities. Furthermore, student learning outcome data can be seen in the

following table, which presents further information regarding student achievement in various aspects of learning that have been carried out.

Table 3. Descriptive Statistics of Cycle II

Descriptive Statistics								
	N	Range	Minimum	Maximum	Sum	Mean	Std. Deviation	Variance
Cycle II	28	20.00	74.00	94.00	2378.00	84.9286	5.42920	51.602

Based on the table above, descriptive statistics for Cycle II show that there were 28 participants with a range of scores of 20 points, indicating a difference between the maximum score of 94 and the minimum score of 74. The total score obtained by all participants was 2378, with an average score of 84.93. This shows that the average score of students in Cycle II was relatively high. The standard deviation was recorded at 5.43, indicating that the variation or spread of scores was relatively small around the average value. The variance was 51.60, which also reflects a relatively consistent level of data spread in the group of participants.

4.3. Discussion

Based on the analysis of the collected data, it can be concluded about the activities and learning outcomes of students in mathematics. The recapitulation of activities and learning outcomes of students per cycle, obtained through the application of differentiated learning, can be seen in the following table.

Table 4. Recapitulation of Student Learning Activities

Learning Activities	Student Activeness	
	$\bar{M}$	Criteria
Cycle I	9.51	Quite Active
Cycle II	17.12	Active

The implementation of the action plan in cycle I showed an increase in student learning activities compared to previous learning, but the results achieved were not fully in accordance with expectations. This can be seen from the average score of student learning activities which reached 9.51, which is quite active, but still requires improvement. In cycle II, which is an improvement from the actions in cycle I, it has shown more optimal results. The average score of student learning activities in cycle II was recorded at 17,12, an increase of 7,61 points.

Table 5. Recapitulation of Student Learning Outcomes

Activities	Completed Students		Students Incomplete		Average
	Frequency	%	Frequency	%	
Cycle I	10	35.71%	18	64.29%	64.75
Cycle II	28	100%	0	0%	84.92

Based on Table 5, the results obtained in Cycle I show that 10 students successfully achieved the learning targets, equivalent to 35.71% of the total students involved. Conversely, 18 other students, accounting for 64.29%, did not meet the targets. Although a portion of the students did not reach the learning targets, these results still provide a positive indication of the implemented learning process. In Cycle II, there was a significant improvement, with 28 students achieving the learning targets, resulting in a 100% success rate. This remarkable improvement indicates that the learning strategies applied in Cycle II were more effective than those in the previous cycle. This demonstrates substantial progress in the learning process, reflecting success in designing and implementing improved learning strategies in each cycle.

This study revealed that the implementation of differentiated instruction played a crucial role in enhancing students' mathematics learning outcomes, particularly in the topic of mathematical induction, which is often perceived as challenging. By adopting a method that adjusts the delivery of material according to the abilities and needs of students, the learning process became more effective and comprehensive. The evaluation results conducted at the end of Cycle I indicated that only 35,71% of students reached the learning targets, while in Cycle II, this figure increased to 100%. This significant improvement highlights better understanding and achievement among students in the taught material. Thus, differentiated instruction has proven to have a tangible positive impact on improving student performance in mathematics, making it more aligned with the characteristics and needs of individual students.

The method of delivering material through a differentiated learning approach has proven highly effective in improving student learning outcomes, as evidenced by the significant increase in average scores from one

cycle to the next. In Cycle I, the students' average score was 64.75, indicating a fairly good achievement, although there was still room for improvement. However, in Cycle II, the average score increased to 84.92, signifying substantial progress in their learning outcomes. This improvement, when calculated using the n-Gain formula, demonstrates.

$$\langle g \rangle = \frac{S_I - S_{II}}{SMI - S_{II}} = \frac{84{,}92 - 64{,}75}{100 - 64{,}75} = \frac{20{,}17}{35{,}25} = 0{,}57$$

Based on the results of the n-Gain calculation, a value of 0,75 was obtained with a moderate category, which means that the results of the second cycle of research and observation produced much better achievements compared to Cycle I. This is in line with [37]–[39], which shows that differentiated learning is not only effective in improving learning outcomes in the moderate category, but also in creating a learning environment that is more inclusive and adaptive to student needs.

5. CONCLUSION

Based on the results of the study, it was concluded that the application of differentiated learning can improve the activity and learning outcomes of mathematics of class XI Automotive students at Muhammadiyah 1 Vocational High School, Sleman in the 2024/2025 Academic Year. The increase in learning activity can be seen from the average score of student activity in cycle II which reached 17.12, an increase of 7.61 compared to the average score in cycle I of 9.51. Learning outcomes also showed a significant increase, where in cycle I of 28 students, only 10 students (35.71%) completed with a score of > 70, while 18 students (64.29%) had not completed with an average score of 64.75. In cycle II, all students (100%) completed with an average score of 84.92. The success of this study shows that differentiated learning can be an effective alternative in improving the quality of learning, creating a more interesting learning atmosphere, and encouraging active student involvement. Therefore, mathematics teachers are advised to consider implementing this method in other classes and materials to avoid monotonous learning and provide a more varied learning experience.

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