

Original Research

Implementation of Differentiated Learning in Science Lessons for Students in Junior High Schools

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Abstract. Students in Indonesia have various characters and different backgrounds, which is a challenge for teachers in Indonesia. In the independent curriculum, teachers have the freedom to choose learning tools that suit the needs of students. The differentiated learning approach reflects learning that responds to the differences of each individual. The study was conducted in a Junior High School in Bandung using two classes a control class and an experimental class. This experimental study used observation instruments, post-test only, and documentation. Data analysis was carried out using descriptive quantitative methods. The results of the study showed that the experimental class had lower average learning outcomes than the control class. Then a normality test was carried out which showed that the data was not normal. Furthermore, the results of the hypothesis test showed that sig (0.565) was greater than alpha (0.005), meaning that the differentiated learning approach did not affect improving student learning outcomes. This is influenced by several factors, namely the number of activities at school, the division of science lesson hours, teaching activities, and the level of difficulty of the questions. However, this study has several advantages including increasing student participation when learning, supporting the implementation of the independent curriculum, and supporting the Sustainable Development Goals (SDGs 4, 10, 8). The things that need to be improved are preparing alternatives to research facilities and infrastructure and planning a more appropriate time allocation.

Keywords: Differentiated learning, Independent curriculum, Learning styles

Introduction

The diversity of student characters is one of the major challenges faced by Indonesian teachers. Education from the thoughts of Ki Hadjar Dewantara means guiding the growth and development of the natural strengths possessed by children (Sari et al., 2023). This is following the objectives of the independent curriculum. The independent curriculum is a curriculum that offers a variety of extracurricular learning that focuses on providing more optimal time for students to explore concepts and develop competencies (Kemdikbud, 2024). In this curriculum, teachers have the freedom to choose various appropriate learning tools, so that learning can be adjusted to the learning styles and interests of students. Teachers have the primary responsibility to design the curriculum through guidance from literature, experts, and colleagues in finding strategies to vary the learning process. Teachers are expected to create learning plans that are tailored to the characteristics and needs of each student (Rasmani et al., 2023).

According to Law Number 20 of 2003 concerning the National Education System (Sisdiknas), education must provide equal opportunities for every student to receive quality education without discrimination, taking into account the diversity of abilities, needs, and



potential of students (Permendikbud, 2016). Teachers also give students the freedom to find their independence physically and mentally. One way to design learning that is tailored to the characteristics of students is to apply differentiated learning.

Differentiated learning is an effort to modify learning in the classroom so that it can accommodate the learning needs of each student well. Differentiation is carried out based on the learning style and development level of students. Differentiated learning is a learning strategy that is launched to support the implementation policy of Merdeka Belajar (Hidayah et al., 2023). Based on a survey conducted, in one class students can have different learning styles (Figure 1.), namely visual, auditory, audiovisual, and kinesthetic. According to De Jager (2013), teachers and students should remain comfortable with diversity in the classroom and see it as a challenge, not a problem. This can be overcome by designing learning that is intended to respond to the known individual differences that exist among students in any classroom (Shalaway, 2005; Tomlinson, 1999). Differentiated instruction is based on the concept that the teacher is a facilitator of information, while students take the lead role in expanding their knowledge through inquiry. One model of learning and approach to differentiated learning is discovery learning. This model includes instructional strategies that focus on active and hands-on learning for students (Dewey, 1997; Piaget, 1954, 1973). (Dewey, 1997; Piaget, 1954, 1973).



Figure 1. Student learning style survey

The success of achieving educational goals is mainly determined by the teaching and learning process which is marked by changes in knowledge, understanding, skills, values, and attitudes (Wulandari et al., 2019). Prabandari (2017) stated that the ideal criteria for completion for each normative and adaptive program indicator is 70% or obtaining a minimum score of 70 for junior high school standards. Then, according to Yakub et al. (2015) classically in one class the learning process is declared successful if the number of students who can achieve $KKM \geq 80\%$ of the total number of students. Meanwhile, the average science test scores of students at SMPN X Bandung showed that 11 students (30.55%) scored above 70, while 25 students (69.4%) scored below 70. So, less than 80% were able to achieve completion in one class.

Several research results are relevant to this study, such as Sulistianingrum et al (2023) which reviews the Implementation of learning styles of students who have sensory learning styles in creating differentiated content. Then the research of Dalila et al (2022) which discusses the influence of differentiated learning in problem-based learning on the cognitive learning outcomes of high school students. In addition, research by Anggraeni & Dewi (2023)

also discusses the analysis of differentiated learning using learning technology based on the discovery learning model in elementary schools. However, no one has conducted research on how to implement differentiated learning at the junior high school level using the discovery learning model. In fact, at the secondary level, students experience significant changes in cognitive, social, and emotional development so that they think more abstractly, critically, and reflectively than elementary school students.

Differentiated learning with discovery learning will also encourage participants to actively seek and find their own knowledge according to their learning style. Linking differentiated learning in secondary schools with the discovery learning model can make the learning process more effective and inclusive. Therefore, the author is interested in conducting research with the title "Implementation of differentiated learning in science lessons for students in junior high schools."

Method

This research is included in the type of quantitative research with a quasi-experimental research design. The researcher applied the Contextual Teaching and Learning (CTL) approach and direct learning model for the control class and the differentiated learning approach and discovery learning model for the experimental class. It is expected that differentiated learning can provide a positive influence on science learning outcomes. This study uses a post-test only so that students are not given a pre-test at the beginning of learning. Student learning outcomes are seen from the average test scores before the material used for research. Then the teacher applies a uniform method for all students in the control class, namely lectures and discussions. While in the experimental class, learning is carried out with a variety of methods according to the learning styles of students. Students are divided into 3 learning styles (visual, auditory, and audiovisual). At the end of learning, students in the control and experimental classes are given post-test questions on what has been learned with the treatment given. Assessment of student learning outcomes is seen based on the criteria prepared by the researcher. The effects that arise due to the treatment given to the experimental class are compared with the control class. Student learning outcomes (post-test) are analyzed using SPSS. The results of the calculations illustrate the results of conventional learning compared to the results of differentiated learning. Figure 2 represents the design of the experimental research process.

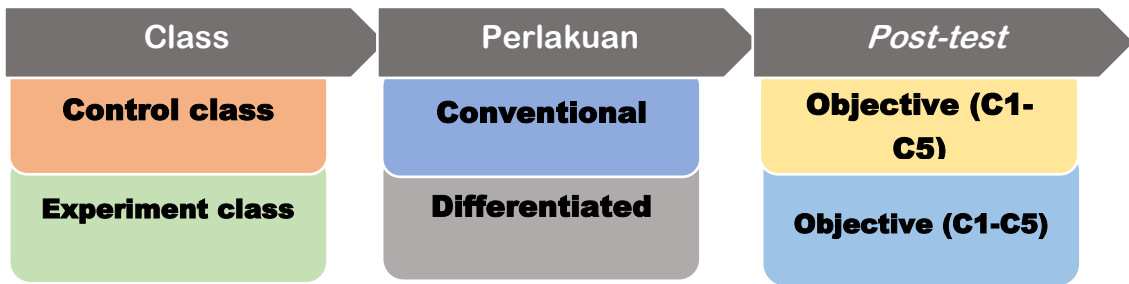


Figure 2. Research design

The sampling used by the researcher is the convenience sampling technique. According to Sugiyono (2015), convenience sampling is a method of determining samples by selecting according to the wishes of the researcher without any special criteria. This research was conducted at SMPN X Bandung, class VII C as the experimental class and class VII F as the control class. Learning took place from November 9, 2023 to December 2, 2023, odd semester. The sample of students in the control class was 33, consisting of 17 boys and 16

girls. While the number of students in the experimental class was 34 people, including 18 boys and 16 girls. There are three types of instruments used in this study, namely observation, tests, and documentation.

1. Observation

The observation stage is carried out before the implementation of the action in the classroom. Observations are carried out by direct interviews at school with science teachers and filling out a Google form by students. The interview data is in the form of qualitative data, then supported by observing and recording all important things that occur during the action. The results show the learning difficulties that occur and learning activities in the classroom. In addition, observations are also carried out to observe researchers when teaching so that the activities that occur in the classroom can be seen. This observation was carried out by the supervising teacher and PPL colleagues. The data collected is in the form of quantitative data measured by the rubric that has been created.

2. Test

The teacher gives tests to students as a means of evaluation to see the effect of learning outcomes on temperature and heat material with a differentiated learning approach. The test is only carried out with a post-test only. This learning outcome test is carried out after the temperature and heat material has been studied. The data collection tool is in the form of a written test in the form of multiple choices from levels C1 to C5. Learning Achievements up to the level of analyzing, then level C5 is used as enrichment. The test questions that have been made have been validated by an expert, namely Dr. Eka Cahya Prima, M.T and Eka Tresnasih, S.Pd. The validation results show that the research instrument is very valid to be used without revision.

3. Documentation

Documentation is a record of past events. Every process of collecting research data, photos are taken for documentation and evidence of research activities. Documentation is taken personally by the researcher during the research. The documentation process is assisted by fellow PPLs who assist in this research.

The data analysis in this study was collected from the average value of learning outcomes after being given treatment (post-test). To see the success of the approach used in science learning outcomes, calculations were carried out using SPSS. The results will be analyzed for causal factors. Then a normality test was carried out with Kolmogorov-Smirnov because the sample was more than 50. The normality test shows the assumption of whether or not the research data is normal. Furthermore, the researcher tested the homogeneity of the data to determine the level of similarity of variance between the control class and the experimental class. The homogeneity test was carried out using Levene's statistics in SPSS. After that, the researcher conducted a hypothesis test. Because the data is homogeneous but not normal, the hypothesis test was carried out nonparametrically with the Man Whitney U Test. This test will identify the difference in the distribution of scores between the control class and the experimental class on questions with different levels of difficulty (C1-C5). In addition, the Man Whitney U Test is used to see the effects of interventions on differences in treatment and the level of difficulty of each question. In addition, to support the research data, the level of difficulty of the post-test questions was calculated. To find out the index number of the difficulty of the questions, the author uses the formula proposed by Du Bois in Sudijono (2006), namely:

$$P = \frac{B}{JS}$$

Description

P : Difficulty Index

B : The number of students who answered the question correctly.

JS : The total number of students taking the test.

The smaller the index obtained, the more difficult the question is. Conversely, the larger the index obtained, the easier the question is. The interpretation of the question difficulty index, the author refers to Thorndike & Hagen (1977) which is shown in Table 1.

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Table 1. Question Difficulty Index

Category	Intepretation
< 0.30	Difficult
0.30 – 0.70	Medium
> 0.70	Easy

Result and Discussion

This section presents the cognitive learning outcomes of students after being given treatment using the differentiation approach in the discovery learning model and the contextual approach in the direct learning model. From the calculation results using SPSS, the average score of the control class was 48.63, while the experimental class was 46.94. This means that the scores of students in the control class were slightly higher than the experimental class. This could be an indication that the control class (which uses conventional teaching methods) produces better average performance compared to the experimental class (which uses the differentiation method). The median score of the control and experimental classes showed the same results, namely 46.69. The similarity of the median values indicates that the distribution of scores in both classes is similar, although the average scores are different. Then, the variation of the control class is 243.01, while the experimental class is 220.60. The greater variation in the control class indicates that the students' scores are more spread out or there is more variation in performance, while the smaller variation in the experimental class indicates that the students' scores are more uniform. The standard deviation of the control class is 15.58, while the experimental class is 14.85. This means that there is more difference between students in terms of performance in the control class compared to the experimental class, which has a slightly lower standard deviation. The minimum score of the control class is 20.01 while the experimental class is 26.68. There are students in the control class who get much lower scores than the students with the lowest scores in the experimental class. On the other hand, the same maximum score in both classes indicates that students with the highest scores in both classes achieve equivalent performance. The maximum score of the control and experimental classes is the same, namely 80.04. Descriptive statistics of student learning outcomes in the control and experimental classes are presented in Table 2.

Table 2. Student Learning Outcomes After Treatment (Post-test)l 2.

<i>Post-test</i>	Control class	Experiment class
Mean	48.63	46.94
Median	46.69	46.69
Variation	243.01	220.60
Standard deviation	15.58	14.85
Minimum	20.01	26.68
Maximum	80.04	80.04

Based on Table 2. the application of differentiated learning in the experimental class was unsuccessful. The results of this study are similar to Jafar's study (2021), that there was no significant difference in learning outcomes between the learning outcomes of students with conventional learning methods and the learning outcomes of students with the differentiation method. Students who are not used to a more varied learning approach can also feel uncomfortable, so they cannot maximize their learning potential in the short term. Then, a normality test is carried out with the aim of seeing whether all variables are normally distributed or not. This normality test is carried out with SPSS using Kolmogorov-Smirnov with test criteria at $\alpha = 0.05$. If $\text{sig} > 0.05$ then the data is normal, while if $\text{sig} < 0.05$ then the data is said to be abnormal. The results of the normality test of the research data can be seen in Table 3.

Table 3. Normality Test of Control Class and Experimental Class

Class	Sig	Alpha	Interpretation
Control	0.04	0.05	Unnormal
Experiment	0.07	0.05	Normal

Based on Table 3. it is known that the significance value for the control class is 0.04, meaning that the data is not normally distributed because the value is smaller than the significance level used, namely alpha 0.05. There is a deviation from the normal distribution in the learning outcome data of the control class. While the significance value for the experimental class is 0.07, meaning that the data is normally distributed because the value is greater than the significance level used. In this study, the hypothesis proposed is,

Ha : The learning outcomes of students at SMPN X Bandung are higher with the application of a differentiated learning approach than conventional learning

Ho : The learning outcomes of students at SMPN X Bandung are not higher with the application of a differentiated learning approach than conventional learning

Hypothesis testing aims to determine the differences in the application of differentiated learning with conventional learning in improving the learning outcomes of students at SMPN X Bandung. Hypothesis testing is carried out using a non-parametric test using the Man Whitney U Test test statistic because the normality assumption is not met. The Man Whitney U Test is a non-parametric statistical test used to see significant differences between the median or distribution in the control class and the experimental class. This test is used when the data is not normally distributed or when the assumptions of the parametric test are not met. In statistical tests, the significance value (p-value) indicates how likely the results obtained occur by chance if there is no difference between the two groups.

The level of significance used in the study is 0.05 (5%). This is the limit used to determine whether the results obtained are statistically significant enough. If the p-value is smaller than α (0.05), then we conclude that there is a significant difference between the two groups, so the alternative hypothesis (H_a) is accepted. However, if the p-value is greater than α (0.05), then there is no significant difference between the two groups so the null hypothesis (H_o) is accepted. The results of the hypothesis test of this study are presented in Table 4.

Tabel 4. Hypothesis testing

	Control	Experiment
N	36	36
Mean	48.63	46.94
α	0.05	
Sig	0.565	
Analysis	Sig > α	
Interpretation	Ha is refused	

Based on the calculation of the Man Whitney U Test in SPSS, the test results obtained mean of the control and experimental classes is 0.565. So, the difference between the control class and the experimental class is 56.5%. The p-value greater than 0.05 indicates that the difference between the control class and the experimental class is not statistically significant. It can be concluded that H_a is rejected and H_o is accepted. The alternative hypothesis (H_a) is rejected, meaning there is insufficient evidence to state that there is a significant difference between the learning outcomes of the control class and the experimental class. While the null hypothesis (H_o) is accepted, meaning that the learning outcomes between the two classes are not significantly different, or that both classes have equivalent results in this test. Thus, the learning outcomes of students at SMPN X Bandung are not higher with the application of a differentiated learning approach than conventional learning. This is influenced by several factors, including:

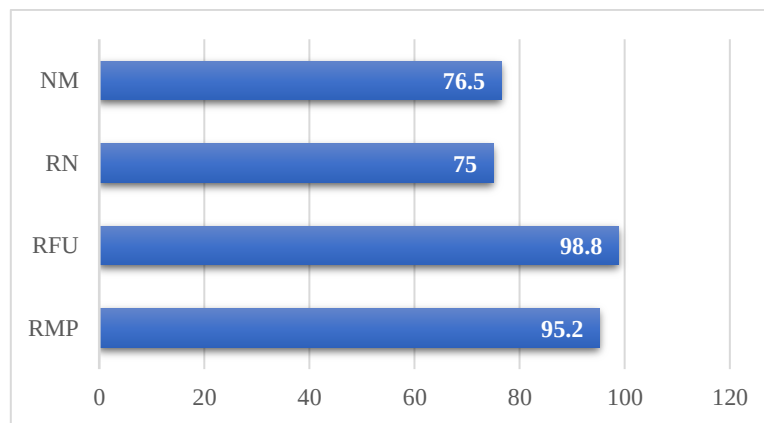
- a. Internal Factor
 - 1) Teaching activity

The internal factor of learning success is a teacher's readiness to carry out learning activities. Before entering the classroom, a teacher must prepare the things needed to support learning activities. Such as preparing a learning design, the content of the material to be taught, valid sources of teaching materials, and even the media used. In accordance with Reskiawan's research (2021), teaching readiness is reviewed from the dimensions of planning, learning process, and evaluation. In this case, the teacher is not ready to teach because he is not ready to master the existing material and the use of teaching methods is lacking. Teaching preparation also affects teaching activities and the quality of student learning. According to Tumanduk et al (2020), if the teacher's readiness to teach is less effective, the learning process will have less impact on student achievement. Likewise, according to Lynch et al (2017), high teacher readiness to teach in schools will be an indicator of a high increase in student learning as a whole. Therefore, researchers conduct assessments by mentor teachers (teacher assessment) and assessments by PPL colleagues (peer assessment) when carrying out teaching activities and implementing research treatments. The assessment results from the mentor teacher show that the researcher has fulfilled all pre-teaching activities, the mastery and delivery of the material are good, the learning is carried out systematically, the use of language is easy to understand, the learning media is effective, efficient, and involves the activeness of students, and reflects and makes a summary at the end of the class. The assessment results are presented in Table 5.

Table 5. Assessment Results by the Mentor Teacher

PRA-TEACHING	MAIN	CLOSING	
Checking student readiness	✓ Mastery of the material	✓ Making conclusion	✓
Aperception	✓ Teaching strategy	✓ Making reflection	✓
	Utilizing time and media	✓	
Motivation	✓ Process assessment	✓ Providing follow-up direction	✓
	Utilizing language	✓	

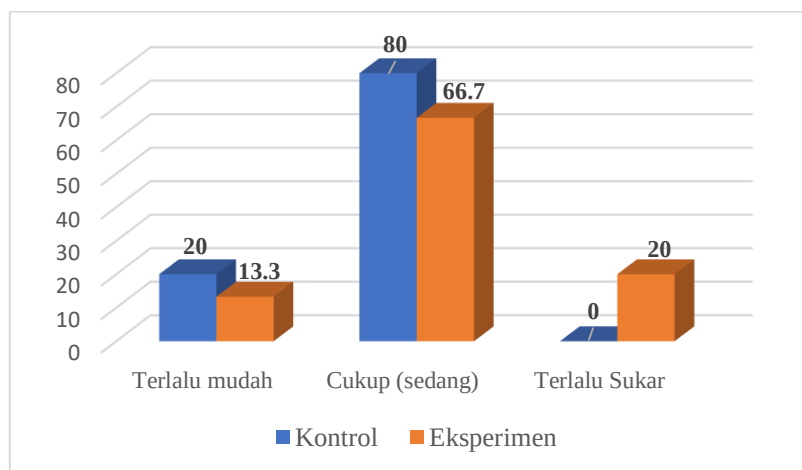
Meanwhile, the results of the teaching activity assessment from PPL colleagues have also reached a value of 86.3%, which means that it has met the criteria for good preparation and teaching activities. The results of the peer assessment are shown in Figure 3.



Gambar 3. Assessment Results by PPL Colleagues

2) Difficulty level

Penilaian dalam pembelajaran merupakan elemen penting dari desain pembelajaran. Assessment in learning is an important element of learning design to provide feedback and improve the overall learning process. Item analysis in this study was conducted to determine the level of difficulty of questions for students in the control class and the experimental class. The questions made were in the form of multiple choices according to the cognitive level of Bloom's Taxonomy which was adjusted to the learning achievement, namely C1 to C4, and C5 as enrichment. Questions that are too easy do not stimulate students to try to solve them, while questions that are too difficult make students give up because they are beyond their abilities. In Arikunto's book (2010), a good question is a question that is not too difficult and not too easy. The results of calculating the level of difficulty of the question items can be seen in Figure 4.



Gambar 4. Result of posttest

Based on the calculations, it was found that according to the control class, the questions presented were at a sufficient (moderate) and too easy index. This means that the questions used were classified as good. Meanwhile, according to the experimental class, the questions presented varied, some were too easy, sufficient (moderate), and too difficult. The level of difficulty of the questions directly affects the ability of students to understand the material and achieve good learning outcomes. Questions that are too difficult can confuse, while questions that are too easy may not challenge students to learn more deeply.

b. External Factor

1) Science subject time

The determining factor for learning success is not only from the internal side, but also external factors, namely the determination of class hours. This is indeed a problem in schools because all subjects want to enter in the morning. Some specific subjects such as science which are relatively complicated require full concentration to follow the lesson, especially in the discussion of temperature and heat in the calculation material. Determining the right time to carry out learning turns out to have a strong influence on the aspect of material absorption. In the findings of Childers & Childers (2018), there is no evidence that the focus of students in the morning and afternoon classes is the same. In agreement with Mukuka et al (2016) who stated that there is little influence between teaching time and student achievement. Then Dimitrova's research (2016) also showed that mathematics scores were significantly lower in the afternoon class.

The science lesson schedule in my control and experimental classes is always in the afternoon. For the control class, my science teaching schedule is on Thursday at 7, 8, and 9 (11.30-14.10 WIB). Moreover, the science lesson schedule is carried out after the Physical Education lesson. The classroom and student situation was no longer conducive because they were tired from exercising. Their concentration was no longer focused on learning. In addition, the science lesson was also cut short by the Dzuhur prayer break. So when they returned to class, the students were tired and wanted to go home immediately. This was seen when the bell rang for home time, they were very happy. Almost the same conditions also occurred in the experimental class. The science teaching schedule in the experimental class was at 4, 5, and 6 hours (09.55-11.40 WIB) or the last hour on Friday. The class I teach is next to the arts and culture class so it is very noisy and I need extra energy so that the material

can be delivered to all students evenly. The music in the next class often disrupts my students' concentration. As a result, learning objectives are difficult.

2) School activity

Proses The learning process can be more meaningful for students if they get direct learning experience. Learning experience is a number of student activities carried out to obtain new information and competencies in accordance with the goals to be achieved. Learning experience obtained online will also be less effective. According to Hamidah & Takhfif (2022) and Ari Susandi et al (2021), students tend to be limited in utilizing learning media and encounter many obstacles when online. Therefore, learning should be done directly at school.

However, when I did research at SMPN X Bandung, there were many activities coinciding with the science lesson schedule in the experimental class (Friday). Starting from the Pancasila Student Profile Strengthening Project (P5), students watched the film "Tegar" together, and celebrated National Teacher's Day until finally the daily test time arrived. Students could not get learning experience with a differentiated approach that had been designed so that the results were lower than the control class. Meanwhile, in the control class, I had the opportunity to teach and provide direct learning experiences to students more often than in the experimental class. According to Bai et al (2022), involvement in teaching and learning activities is a strong mediator between facilities and learning outcomes. The results of the study by Saggaf & Salam (2017) also stated that the hypothesis of the influence of time management in class on learning outcomes was accepted. Strengthened by the results of the study by Zhang et al (2022) that learning experiences significantly improve learning outcomes. The implementation of research activities can be seen in Table 6.

Tabel 6. Schedule of research

Date	Activity	Class
Thursday, 9th November 2023	Temperature and heat material	Control
Friday, 10th November 2023	Students watch the film "Tegar" together	Experiment
Thursday, 16th November 2023	Heat transfer material	Control
Friday, 17th November 2023	Heat material and calculating the amount of heat	Experiment
Thursday, 23th November 2023	Expansion material	Control
Friday, 24th November 2023	National teacher day celebration	Experiment
Thursday, 30th November 2023	<i>Post-test</i>	Control
Friday, 1st Desember 2023	<i>Post-test</i>	Experiment

The results showing no significant difference between conventional learning methods and differentiated learning (based on the Man Whitney test) provide several important implications for educational practices at SMPN X Bandung, including:

a. Evaluation of the implementation of differentiated learning

Although differentiated teaching did not show significant results in this study, this may be because this method has not been fully optimized. SMPN X Bandung can further evaluate how this method is applied in the classroom, whether the needs of students are really well mapped, and whether teachers receive sufficient training to manage heterogeneous classes. In many cases, differentiated teaching requires a longer adaptation period for teachers and students. Some students may be more comfortable with conventional learning methods that are structured and linear. They feel safer when they know what to expect and how to learn

in the way they are used to. Conversely, differentiation methods that require more active involvement from students can be felt more confusing or even stressful.

b. Teacher development

SMPN X Bandung can continue to provide training to teachers and monitoring implementation to optimize its implementation. Teachers at SMPN X Bandung need more in-depth training in differentiated teaching methods to ensure that they can be implemented effectively. This training can include classroom management, formative assessment, and how to map individual student needs. Teachers can be invited to have open discussions about the challenges and successes in implementing differentiated methods in the classroom. This can be a space to share best practices and strategies that have proven effective in different contexts. The advantages of this study are:

1. Level of student participation

During the research process, students were quite enthusiastic in participating in science learning. This is evident from the results of the LKPD of students in the control class, which were 100% submitted and obtained very good grades. Although only 25% of students in the experimental class submitted LKPD because many science lessons coincided with school activities. However, the LKPD results from the experimental class were classified as very good. In addition, during learning, students also actively participated in working on questions outside the LKPD. Students were more actively involved in learning activities, which contributed to a more positive learning experience.



Gambar 5. Student activity

1. Merdeka Curriculum Implementation

The independent curriculum is a program that emphasizes the independence and freedom of teachers and students to be creative and innovative in order to maximize their potential by exploring their full potential (Nurhayati et al., 2022). The role of the teacher is

not only as a deliverer of material to students, but the role of the teacher is as an educator who provides the best and most meaningful education for students. Education is directed at the quality of learning characterized by the profile of Pancasila students and human resources who have superior competencies in facing global challenges. Differentiated learning is motivated by the diverse learning needs of students, in line with the philosophy of Kihajar Dewantara. Differentiated learning is a form of effort in a series of learning that pays attention to students' needs in terms of academic readiness, academic profile, interests, and talents (Tomlinson & Moon, 2014). Before implementing differentiated learning, teachers and schools have access to information on how to implement the differentiation procedure. This research is in line with the principles of the Independent Curriculum, which emphasizes flexible learning and is oriented towards student needs. The teaching methods used help students to learn independently and develop critical thinking skills..

2. *Sustainable Development Goals* (SDGs) Encouragement

Differentiated learning is an approach that is tailored to the different needs and abilities of learners. This approach helps learners achieve optimal learning outcomes, regardless of their background, abilities, and needs. Differentiated learning supports several points in the SDGs, namely:

(a) Increasing learning quality (4)

Education is one of the pillars for achieving the Sustainable Development Goals (SDGs). The fourth goal of the SDGs emphasizes “Quality Education” and requires everyone to acquire the knowledge and skills needed to promote education for sustainable development (Giangrande et al. 2019; Kopnina & Poldner, 2021). Differentiated learning can help ensure that all learners have equal opportunities to learn and thrive. This is essential to achieving SDG 4, which is to ensure that all people regardless of gender, race, ethnicity, or socio-economic status have access to quality education.

(b) Reducing the gap (10)

The Covid-19 pandemic has led to the largest increase in inequality between countries in three decades. Reducing inequality both within and between countries requires equitable distribution of resources, including investment in education and skills development. Inequality based on income, gender, age, disability, sexual orientation, race, class, ethnicity, religion and opportunity persists worldwide. Inequality threatens long-term social and economic development, has a negative impact on poverty alleviation, and undermines people's sense of fulfillment and self-esteem. Differentiated learning can help reduce educational gaps between learners from different backgrounds. This is important to achieve SDGs 10, namely reducing inequality within and between countries. According to Yunaini et al. (2022), schools and teachers can be more flexible in innovating to make learning active, creative, and independent to create a fun learning atmosphere regardless of existing social differences.

(c) Improve the quality of life(8)

Pembelajaran Differentiated learning can help learners develop the skills and knowledge they need to live independently and productively. This is essential to achieving SDGs 8, namely supporting inclusive and sustainable economic growth, decent work and productive and sustainable economic growth. No country can achieve sustainable economic development without major investments in human resources. Education is what transforms a person to live a better life and brings broad social benefits to individuals and society. It increases the productivity and creativity of society and encourages entrepreneurship and technological progress (Sarah Javed et al., 2016). Education is what transforms a person to

live a better life and brings broad social benefits to individuals and society. Some things that need to be improved in this study are,

1. Time management

Inappropriate time management is one of the shortcomings in this study. Learning time should have been calculated better. However, the many activities at school and taking up class hours make the time allocation plan that is prepared inappropriate. For further research, I must be able to find other alternatives so that differentiated learning can still run effectively. The relatively short research time also overwhelmed me and made me unable to carry out the treatment as planned. In addition, my teaching readiness and teaching activities must be further improved so that the learning targets that have been set can be achieved.

2. Preparing alternative facilities and infrastructure for learning

The facilities and infrastructure available at the school need to be utilized and managed for the benefit of the learning process at school. This management is intended so that the utilization of facilities and infrastructure in schools can run effectively and efficiently. According to Goffar & Agustin (2021), the success of learning in schools is supported by the effective and efficient utilization of all educational facilities and infrastructure in schools. In this study, facilities and infrastructure became an obstacle in implementing differentiated learning. Learning should be carried out using a projector to display interactive PPT, play games, and display videos. However, the limitations of the projector and the schedule that coincided with science lessons in other classes meant that the use of the projector had to be alternated. Then the condition of the laboratory which was being renovated made the tools unable to be used effectively. For future research, several alternative assessment methods can better measure students' understanding in different learning environments, namely:

- a) Project-based assessment: This method involves students in projects that require the application of knowledge and skills in real-world contexts. By working on projects, students can demonstrate their understanding more practically and creatively, rather than just answering multiple-choice questions.
- b) Portfolio: Portfolios allow students to collect their best works over some time. This provides a more comprehensive picture of students' abilities, their development over time, and their thinking processes. Teachers can evaluate not only the final results but also the progress and effort of students.
- c) Formative Assessment: Using formative assessments, such as quizzes, discussions, and ongoing feedback throughout the learning process, can help teachers understand students' understanding in real-time. By providing immediate feedback, students can refine their understanding before the final assessment.
- d) Collaborative Activities: Involving students in group discussions or debates can measure their understanding through interaction with peers. In this activity, students can provide explanations and arguments to each other, which helps them internalize knowledge better.
- e) Practical Exams: Practical exams, such as demonstrations or presentations, allow students to demonstrate their skills and understanding more directly. This can be especially effective in subjects that require the application of skills, such as science or art.

Conclusion

Differentiated learning approach reflects learning that responds to individual differences. However, in this study, differentiated learning could not improve the science learning outcomes of students at SMPN X Bandung. It can be seen from the average learning outcomes of the control class which was 48.63 while the experimental class was 46.94. Then,

the results of the normality test showed that the control class was not normal (0.04), while the experimental class was normal (0.07) and both classes were homogeneous (0.393). Furthermore, based on the results of the hypothesis test, the application of differentiated learning at SMPN X Bandung did not affect the improvement of student learning outcomes (H_0 is accepted). This failure was caused by several factors, namely the number of activities at school, the division of science lesson hours, teaching activities, and the level of difficulty of the questions. This makes the application of differentiated learning ineffective and inefficient so that the results also do not increase. However, this study has several advantages including increasing the active participation of students while learning, supporting the implementation of the independent curriculum, and supporting the Sustainable Development Goals (SDGs 4, 10, 8). The things that need to be improved are the readiness of other alternatives related to research facilities and infrastructure and more appropriate time allocation.

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