

Implementation of *Merdeka Belajar* Differentiated Instruction in Science Learning to Improve Student's Science Literacy

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Abstract: The diversity of learning needs of students needs to be accommodated in learning. In addition, Indonesia's scientific literacy ability is still relatively low due to low interest or motivation to learn. Therefore, this study aims to describe the improvement of students' scientific literacy skills through independent differentiated instruction. This study used a pre-experimental type experimental method with a one-group pretest posttest design. The research sample was conducted by non-probability sampling using a type of purposive sampling. The subjects of this study were 33 students of class VII C SMP Negeri 7 Banjarmasin. Data collection techniques use test instruments, response questionnaires, and documentation. The data analysis technique uses t-test and N-gain test. The results showed that there was an increase in students' scientific literacy skills through the implementation of independent differentiated instruction which was shown by the results of the t sig test ($0.000 < \alpha = 0.05$ with a large increase of 0.71 or 71.33% in the high category.

Keywords: Differentiated instruction; Science learning; Scientific literacy

Introduction

Each individual has a different character. Likewise with students in a class that has a lot of diversity such as cognitive levels, learning styles, learning interests, and learning profiles. This diversity must be well accommodated so that children can feel the benefits and impacts of learning for themselves because each child will become the next generation of the nation (Fahmi et al., 2019). They need to be led to become human beings who are constantly learning and have certain abilities to face the world in the future. One of the abilities that every individual needs is science literacy (Jamilah et al., 2023). As humans who are overwhelmed by problems, of course, they need this science literacy ability to help them solve problems (Fahmi et al., 2021). Teachers are among those whose role is to direct and facilitate children to develop their abilities in accordance with their respective characters and potentials. The reality that occurs in Indonesia is the low ability of science literacy and often teachers who generalize children's abilities. The existence of discontinuity between

expectations and reality requires efforts to improve the quality of education (Nikmah et al., 2023). One of them is the application of differentiated learning to improve the science literacy ability of each individual. Therefore, this research needs to be carried out.

The government continues to strive to improve the quality of education, including by changing the paradigm of education from teacher-centered to student-centered (Af'idayani et al., 2018; Rahayu et al., 2018). Minister of Education, Culture, Research and Technology, Nadiem Makarim promoted the view that every human being has a different and extraordinary ability to overcome individual problems himself. This program by the Indonesian Ministry of Education and Culture is named the Merdeka Belajar program (Bayumi et al., 2021; Lestari et al., 2023). One of the efforts to achieve the successful implementation of the Merdeka Belajar program, Nadiem Makarim initiated the driving school program and changed the paradigm of education in Indonesia according to the concept of 21st century learning as an effort to create superior human resources (Faiz et al., 2022).

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One approach that is in accordance with the concept of Merdeka Belajar is a differentiated instruction approach or method. In Module 2.1 of the Driving Teacher, it is explained that differentiated instruction can be implemented to accommodate the diverse learning needs of learners (Kemdikbud, 2022). Differentiated instruction is learning that accommodates the learning needs of students by adjusting the learning process in the classroom according to interests, readiness and learning profiles. This difference in student learning needs creates gaps between students. Through differentiated instruction allows students to be able to learn in their own way and the teacher acts as a facilitator in accommodating differences in their learning ways. According to Tomlinson, differentiated instruction is learning that adapts to the learning needs of each individual. The learning needs in question are readiness to learn, learning profiles, and the interests and talents of students (Herwina, 2021; Putra et al., 2021).

Differentiated instruction is a teaching strategy according to the talents, abilities and learning styles of students. Through differentiated instruction, teachers are expected to be able to modify teaching instruction to strive for the success of diverse learners (Magableh et al., 2020). Differentiated instruction does not mean that learning must be done differently for each individual, but rather facilitates or accommodates learning strategies so that the learning needs of different students can be met (Herwina, 2021).

In line with the philosophy of education according to Ki Hajar Dewantara which is also implied in the application of an independent curriculum, that education is an effort to guide every child's natural strength as an individual and society (Fahmi et al., 2019). Educators become civil servants in cultivating the strengths that exist in students by providing freedom but still providing direction so that students do not lose direction. Students are free to adjust learning according to their interests, learning styles and readiness to understand the material so that it can improve learning outcomes (Wahyuni, 2022).

Judging from the current goals of Indonesian national education, in reality not all students develop according to their character. Because in its implementation, current learning has not been able to accommodate the learning needs of students and causes a gap between high and low abilities. Mismatch between expectations and reality due to being too focused on the demands of the curriculum to be followed by students with different learning needs (Fahmi, 2018). This affects learning motivation and has an impact on student learning outcomes (Herwina, 2021).

Motivation is one of the important factors in the learning process. If students have motivation in learning, it will cause a sense of enthusiasm and activity in learning in class (Putra et al., 2023). Teachers need to explore what can increase student motivation in the midst of different subjects or materials, the level of difficulty and the variety of interests and talents of students in a class. Of the many methods used in learning, not all of them can increase student learning motivation. This can be triggered by low interest in learning, learning is not yet contextual, and students are only interested in learning if it suits their talents (Rahman, 2022). In line with the 21st century skills that are important for every individual, as one of the scientific fields that most need to be mastered, science requires the presence of skills to apply science concepts, one of which is the ability to science literacy (Kusasi et al., 2021). Science literacy is closely related to environmental problems, technological developments and science in society so that it needs to be improved in each individual (Fahmi et al., 2021). Science literacy according to PISA refers to three indicators of competence including: 1) explaining phenomena scientifically; 2) evaluate and design investigative efforts; and 3) scientific interpretation of data and evidence (Fahmi et al., 2022).

The Programme for International Student Assessment (PISA) in 2018 announced that the science literacy rating of secondary students in Indonesia is still relatively low. Indonesia ranks 70th out of 79 countries. According to the results of the analysis of Fuadi et al. (2020) and Istyadi et al. (2022) that one of the factors causing the low science literacy ability of students in Indonesia is non-contextual learning. Understanding basic concepts has not been fully connected with problems in everyday life so that students consider science to be a difficult lesson to understand. Through differentiated instruction, learning is applied in line with the learning character of students through differentiation strategies of content, processes, products. Through content and process differentiation strategies, students can use media or teaching materials according to the level of readiness and learning profile of students. Students can also create learning products according to their respective interests in the form of videos, images, or writing. It is hoped that through differentiated instruction it will be able to create science learning that accommodates the different learning needs of students so that it can increase learning motivation and students will be able to understand and apply the knowledge they have to daily problems.

Method

Research Design

This study used a quantitative approach with a pre-experimental type experimental method of one-group pretest posttest design. The focus of the study was to see the improvement of science literacy skills in one experimental class before and after the application of differentiated instruction.

Table 1. Research Design (Sugiyono, 2015)

Pretest	Treatment	Posttest
O ₁	X	O ₂

The population used in this study was grade VII students of SMP Negeri 7 Banjarmasin. The sampling technique in this study is non probability sampling using a type of purposive sampling. The sample studied in this study was class VII C at SMP Negeri 7 which amounted to 33 people.

Research Instruments

The aspect of science literacy measured in this study is the aspect of competence. The instruments used are test and non-test instruments. The test instrument consists of 9 description questions on Indonesian ecology and biodiversity material that have been adjusted to science literacy indicators. While the non-test instrument used is a student response questionnaire. This research instrument was validated by 5 validators and analyzed using content validation formula by Aikens' V and reliability with Alfa Chronbach formula.

Research Procedure

The study was conducted as many as 3 meetings. At the initial meeting, initial data was taken in the form of a pretest to see the science literacy ability of students before being given treatment. In the second and third meetings, differentiated instruction was carried out on Indonesian ecology and biodiversity materials. At the end of the meeting, data was taken in the form of a posttest to see the science literacy ability of students after differentiated instruction was applied and gave a response questionnaire to determine the response of students to the learning that had been done. To determine the implementation of differentiated instruction in the classroom, the two differentiated instruction meetings were observed by two observers through observation sheets of the implementation of teaching modules. The criteria for assessing science literacy ability can be seen in the table.

Table 2. Science Literacy Assessment Criteria (Rahmadani et al., 2018)

Category	Value
High	X >80
Medium	60 ≤ X ≤ 80
Low	X <60

Data Analysis

To see the magnitude of the increase in science literacy ability, the N-gain test is used with the following formula.

$$N - gain = \frac{post\ test\ score - pre\ test\ score}{ideal\ score - pre\ test\ score} \quad (1)$$

Information:

Posttest score = posttest score obtained by students

Pretest score = pretest score obtained by students

Ideal score = maximum score that can be obtained

The results of the N-gain calculation are further categorized in the table 3.

Table 3. Science Literacy N-gain Criteria

Result	Criterion
N-gain > 0.70	High
0.30 ≤ N-gain ≤ 0.70	Medium
N-gain < 0.30	Low

Furthermore, a statistical test was carried out by testing normality and a t-test using the SPSS application version 25 for windows. The significance level (α) is 0.05 or 5%.

a) Normality test

The normality test used is the Kolmogorov-Smirnov test with a significance level of 95% with α = 0.05. Determination of normality test result decisions, namely: significance > 0.05 then normally distributed data; significance < 0.05 then the data is not normally distributed.

b) Paired sample t-test

This test is carried out to see if there is a significant difference between the pretest and posttest results. The research hypothesis is:

H₀: there is no significant difference between pretest and posttest results (no improvement in science literacy skills).

H₀: there is a significant difference between pretest and posttest results (there is an increase in science literacy skills).

If the value of sig. > 0.05, then H₀ is accepted and H_a is rejected. Conversely, if the value of sig. < 0.05, then H_a is accepted and H₀ is rejected.

Result and Discussion

Differentiated Instruction Outcomes

Differentiated instruction is carried out by adjusting the learning needs of students. At meeting 1, learners are differentiated based on their learning readiness with content and process differentiation strategies. The mapping of student learning readiness is presented in figure 1 and figure 2.

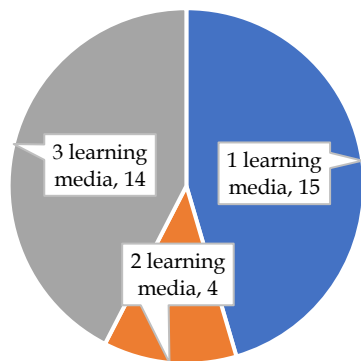


Figure 1. Learning readiness mapping for content differentiation

Based on figure 1, students are facilitated with 3 types of learning media, namely videos, infographics, and powerpoint. They can choose to use any medium

they find easy to understand and use. They can use one to three types of media before they're finally ready to take the quiz. The quiz consists of three levels, namely easy, medium, and difficult levels. Students can choose any level they want to do first.



Figure 2. Learning readiness mapping for process differentiation

For content differentiation, there are 4 students who learn with 3 types of media, 14 students learn with 2 types of media, and 15 students learn with 1 type of media. As for process differentiation, namely the level of quizzes that students choose to do first. All students choose to do the easy level first. The work of students is presented in table 4.

Table 4. Differentiation Outcomes Based on Readiness to Learn

Forms of differentiation	Average	Science literacy categories
Learn with 3 types of learning media, easy level quiz	81.50	High
Learn with 2 3 types of learning media, easy level quiz	81.98	High
Learn with 1 learning media, easy level quiz	76.81	Medium
Overall average	79.57	Medium

Based on table 4, it is known that students who choose to learn with 3 media and quiz level easily get a score of 81.50 in the high category, students who choose to learn with 2 media and quiz level easily get a score of 81.98 in the high category, and students who choose to learn with 1 media and quiz level easily get a score of 76.81 in the medium category. The average score is 79.57 in the medium category.

At the meeting 2 learners were differentiated based on their learning profile with process differentiation strategies. The mapping of student learning profiles is presented in figure 3.

Based on the graph, students are given the option to work on student worksheets (LKPD) in groups (3-5 students), in pairs, or individually. 4 students chose to form groups, 20 students chose pairs, and 9 students chose to work individually. The results of the work of students are presented in table 5.

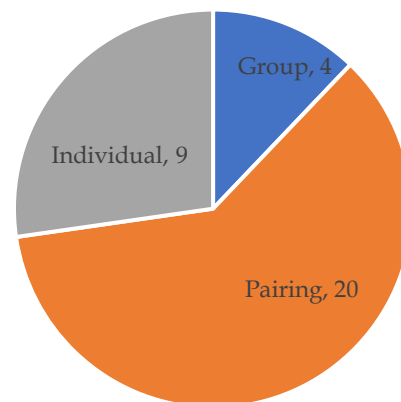


Figure 3. Learning profile mapping for process differentiation

Table 5. Differentiation Outcomes Based on Learning Profiles

Forms of differentiation	Average	Science literacy category
Work in groups	89.00	High
Work in pairs	87.40	High
Work individually	81.89	High
Overall average	86.09	High

Based on table 5, it is known that students who chose to do LKPD in groups obtained a score of 89.00 in the high category, students who chose to work in pairs obtained a score of 87.40 in the high category, and students who chose to work individually obtained a score of 81.89 in the high category. The average score was 86.09 in the high category.

At the end of the meeting, students are assigned to make learning products in the form of videos, images, or writings themed on environmental pollution. Students can choose the type of product created based on their interests. The mapping of learners' interests is presented in figure 4.

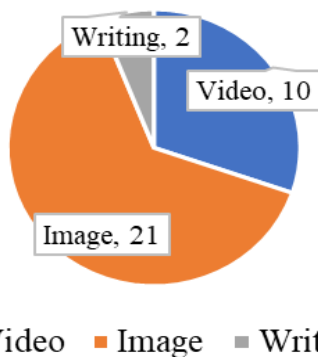


Figure 4. Interest mapping for product differentiation

For product differentiation, there were 2 students who chose to make learning products in the form of writing, 10 students made videos, and 21 students made images. The results of the assessment of student products are presented in table 6.

Based on table 6, it is known that students who choose to make videos get a score of 87.80 in the good

category, students who choose to make pictures or posters get a score of 86.11 in the good category, and students who choose to make writing get a score of 91 in the very good category. The average score is 88.30 in the good category.

Table 6. Results of Interest-Based Differentiation

Forms of differentiation	Average	Category
Create a video	87.80	Good
Create an image or poster	86.11	Good
Create writing	91	Excellent
Average	88.30	Good

Science Literacy Test Results

The results of the science literacy test obtained through the pretest and posttest are presented in table 7.

Table 7. Descriptive Statistical Results of Science Literacy Tests Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Pretest	33	18.52	62.96	44.23	11.22352
Posttest	33	62.96	100.00	83.61	7.96772
Valid N (listwise)	33				
N-gain score				0.7131	
% N-gain				71.31	High category

Based on the data in table 7, it is known that the average pretest score is 44.23 in the low science literacy category. After applying differentiated instruction, there was an increase shown by a posttest score of 83.61 in the high category. Increased science literacy ability by 71.31% with a high increase category.

Statistical Test Results of Science Literacy Tests

Statistical tests of science literacy tests are needed to test research hypotheses and answer problem formulations. The pretest and posttest result data were tested for normality before the hypothesis test was carried out. A summary of statistical test results is presented in table 8.

Table 8. Summary of Statistical Test Results

Test	Kind	Result	Decision	Conclusion
Normality	Kolmogorov-Smirnov	Sig. pretest = 0.200 Sig. posttest = 0.099	H ₀ Accepted	Normal distributed data
T-test	Paired Sample t-test	Sig = 0.000	H ₀ rejected	There is an increase in science literacy skills (there are differences)

Based on table 8, it is known that the results of the normality test with the Kolmogorov-Smirnov test at the pretest significance level of 0.200 and posttest of 0.099. Both pretest and posttest obtain significance values

greater than $\alpha = 0.05$ which means H₀ is accepted. The conclusion of the normality test is that the data has been normally distributed. Furthermore, a hypothesis test was carried out using the -t test with the type of Paired

Salmples t-test. Based on the table, it is known that the significance value obtained is 0.000. The value is less than $\alpha = 0.05$ which means H_0 is rejected and H_a is accepted. The result of the hypothesis test is that there is a significant difference between the pretest and posttest results where the average posttest score is greater than the average pretest score. So it can be concluded that there is an increase in science literacy skills after the implementation of independent learning differentiated instruction.

Results of the Response Questionnaire

Response questionnaires are given to see students' responses to learning. The results of the response questionnaire are presented in table 9.

Table 9. Descriptive Statistical Results of Science Literacy Tests

	Criteria	Percentage
Score level	Excellent	12.12%
	Good	87.88%
Response	Quite positive	10%
	Positive	90%
Average	Good and positive	77.65%

Based on table 9, it is known that the score level on the very good criteria obtained a percentage of 12.12% and good criteria of 87.88%. The response given by students on the criteria was quite positive by 10% and positive by 90%. The average response of students on the criteria is positive and good with a percentage of 77.65%.

Observations of Learning Implementation

The observation sheet for the implementation of learning was filled by 2 observers for 2 meetings. Meeting 1 observation sheet contains 21 statement items and meeting 2 observation sheet contains 16 statement items with a score range of 1-4. The results of the calculation of the observation sheet for the implementation of learning can be seen in the following table.

Table 10. Observations of Learning Implementation

The meeting to-	Score percentage
I	91.07
II	98.44
Average	94.76
Category	Excellent

Based on table 10, it is known that the percentage of scores given by observers at the first meeting was 91.07% and at the second meeting was 98.44%. The overall average is 94.76% in the excellent category.

Science literacy skills measured in this study focus on aspects of competence only. The one used consists of

9 description questions with a 3-3-3 format. Indicators explaining scientific phenomena are presented in questions number 1, 2, and 3. Indicators interpreting scientific data and evidence are presented in questions number 4, 5, and 7. Indicators evaluating and designing scientific investigation efforts are presented in questions number 6, 8, and 9. After differentiated instruction is applied, science literacy skills have improved. This can be seen from the posttest results that are higher than the pretest results and statistical test results that state there is a significant difference between the pretest and posttest results. So it can be said that differentiated instruction helps improve the science literacy ability of students. The factor causing the increase in students' science literacy ability is learning that is tailored to the needs of students which also causes an increase in student learning motivation. According to Pratama et al. (2019), Putri et al. (2021), and Noor et al. (2023) learning motivation is one of the factors that can improve achievement or learning outcomes. Furthermore, Fahmi et al. (2019), Handiyani et al. (2022), and Istyadji et al. (2022) stated that implementing learning that involves more active students can increase students' learning motivation.

Differentiated instruction can accommodate the different learning needs of learners. Students can choose in what way they learn using the facilities that have been provided. For example, there are students who choose to learn with many media and then feel ready to take an easy level quiz. There are also those who only learn with 1 media and are ready to do easy level quizzes. Learners are also given the option to study individually, in pairs, or in groups. In addition, students are also given a choice of products as a form of assignment tailored to their respective interests. It is undeniable that learning experiences that let students take part in making decisions according to their learning readiness, learning profile, or interests are important so that the differences that exist among students can still be accommodated so that learning objectives can be achieved properly. According to Herwina (2021), differentiated instruction can optimize student learning outcomes because it can adjust to their learning needs.

The implementation of differentiated instruction in the classroom is going well. This statement is supported by the observations of observers with very good categories and with the positive response of students to the application of differentiated instruction so that it can be concluded that the application of differentiated instruction is well applied in the classroom to accommodate the different learning needs of students so as to facilitate the achievement of learning objectives and improve scientific literacy skills. This is in line with previous research that differentiated learning can

improve the ability of student learning outcomes in science learning (Suwartiningsih, 2021).

Conclusion

Independent differentiated instruction can improve students' science literacy skills. This is evidenced by obtaining an N-gain score of 0.71 on the criteria for high improvement. Differentiated instruction can be applied to accommodate the different learning needs of students to facilitate the achievement of learning objectives, especially in science learning.

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Author Contributions

The authors in this research are divided into executor and advisor.

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Conflicts of Interest

The authors declare no conflict of interest in this research.

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