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THE EFFECT OF PROBLEM-BASED LEARNING MODEL ON STUDENTS' SCIENCE LITERACY SKILLS IN CLASS VII ECOLOGY MATERIAL IN PUBLIC JUNIOR HIGH SCHOOL 27 MEDAN

Natasya,T[1 a)], Hardinata,A[2b)]

[1,2]Departement of Science Education, Universitas Negeri Medan

[b)]**E-mail :** aristohardinata@unimed.ac.id

ABSTRACT

This research aims to investigate the influence of the Problem Based Learning (PBL) model on the science literacy skills of seventh-grade students in ecology subject at SMP Negeri 27 Medan. The research method employed was quantitative with a sample of 64 students from classes VII-6 and VII-5, selected using purposive sampling technique. The instrument used was a science literacy test, with the independent variable being the teaching model (PBL and direct instruction) and the dependent variable being the students' science literacy skills. The results of the research indicate that the implementation of the PBL model has a significant influence on the science literacy skills of seventh-grade students in class VII-6. Initially, the science literacy skills of students in class VII-6 were at level 2 with a score of 37.50, classified as insufficient. However, after the implementation of the PBL model, the science literacy skills increased to level 4 with a score of 69.58, classified as sufficient. In conclusion, the application of the PBL model was effective in improving the science literacy skills of students in ecology subject at class VII-6 of SMP Negeri 27 Medan. This finding provides important implications for the development of problem-oriented learning approaches to enhance students' science literacy.

Keywords: PBL, Science, Literacy, Ecology

INTRODUCTION

In the twenty-first century, education is becoming increasingly important to ensure that students can learn and develop, use media and information technology, work and survive through skills. The Ministry of Education and Culture of the Republic of Indonesia has created a new curriculum for primary schools (SD), junior secondary

schools (SMP), senior secondary schools (SMA), and vocational secondary schools (SMK) that updates the three principles of 21st century education. The 21st century requires an education that equips students with the skills needed to compete in the global economy. The 21st Century Skills Partnership emphasizes the importance of teaching students how to collaborate, communicate effectively, think critically and creatively (Pratiwi et al., 2019).

Natural Science (IPA) is a concept in education that is closely related to everyday life and concentrates on understanding natural phenomena. Students are encouraged to experience and understand nature scientifically through science education. At the junior high school level, the purpose of learning science is to support students in getting to know themselves and the natural environment, as well as developing an understanding of scientific concepts that are relevant and applicable in routine life. To actively participate in solving science problems and ideas, one must be able to apply their knowledge in formulating questions, generating new knowledge, proposing scientific explanations, and making conclusions supported by evidence. This ability is known as science literacy (OECD, 2019).

In fact, the science literacy skills of Indonesian students from 2000 to 2022 have proven to be low because the scores tend to be lower than the average of OECD member countries. This is reflected in the Program for International Student Assessment (PISA) mapping results. An overview of Indonesian students' PISA results for science literacy is presented below.

Table. 1 Summary of Science Literacy Achievements of Indonesian Students in PISA

Tahun PISA	Nilai	Ranking
2000	360	40 dari 50 Negara
2003	370	39 dari 40 Negara
2009	383	57 dari 65 Negara
2012	382	64 dari 65 Negara
2015	403	65 dari 73 Negara
2018	396	70 dari 78 Negara
2022	383	66 dari 80 Negara

Based on this data, further efforts are needed to improve Natural Sciences (IPA) learning so that scientific literacy in Indonesia can increase. This is because scientific literacy allows individuals to critically evaluate and design scientific research, increasing their overall understanding of science (Hardinata, at al). One strategy that can be implemented is to develop variations in learning models. Using a variety of learning models provides opportunities for students to hone collaborative, problem-solving and critical thinking skills. This approach can also stimulate students' interest in science by linking learning to more relevant daily life contexts.

The results of observations of teaching and learning activities in class VII of SMP Negeri 27 Medan in the 2023/2024 school year show that teachers tend to rely on the lecture method in delivering material, causing a lack of student interest in digging deeper into the concepts taught due to the lack of use of diverse learning models. In addition, learning is done without using media due to the lack of facilities and infrastructure such as laboratories that are not functioning. Students lack active participation in the teaching and learning process when learning is done with a teacher-

centered perspective. Based on observations during learning activities in the classroom, if only the lecture method is used, students' science literacy skills will be less developed. In addition, the application of such learning methods causes students' abilities to explain phenomena scientifically, evaluate and design scientific research, and interpret data and evidence scientifically to experience limited development. Based on the results of interviews with science teachers of SMP Negeri 27 Medan class VII, it is known that students' ability to convert data between formats, analyze data, and make conclusions from data is still weak. In addition, it is also known that teachers in this school have never conducted a science literacy test. Based on the teachers' arguments, they stated that teachers did not fully understand the concept of science literacy. This stems from teachers' arguments that consider reading and writing activities carried out at school as science literacy. Teachers can use student-centered learning strategies to address and improve students' understanding of science literacy.

One of the efforts to fix the problem is by applying the Problem Based Learning (PBL) learning model. The problem-based learning model is a learning model that exposes students to problems related to everyday life to help them understand the learning material. In this model the problem is presented at the beginning of the learning process and students are asked to solve the problem. The problem-based learning model (PBL) is learning that begins with practical (real world) problems that are appropriate to the topic so that it can train students to think critically in solving problems and develop problem-solving skills (Nofiziarni et.al., 2019).

Ecology material is considered appropriate because it is related to students' lives. In addition, students are given the opportunity to express their opinions critically and creatively according to the Ecology literature so that their understanding of the literature can be improved (Mayarni & Yulianti, 2020). Therefore, Ecology issues are considered quite relevant because they are related to real scientific events and phenomena. Teachers should also create active learning activities that allow students to explore concepts on their own. The applied learning model has the ability to further create student interest and also improve their thinking skills (Ariani & Ratnawulan, 2020). PBL as an effort to improve students' science literacy is supported by Kurniawati and Hidayah's research (2021) This study found that Problem Based Learning (PBL) assisted by Blended Learning had a significant positive effect on students' science literacy skills. The experimental group showed better performance in analyzing and evaluating phenomena, as well as in identifying scientific issues and providing scientific explanations for a phenomenon. The experimental group, which received PBL based on Blended Learning, showed higher improvement in science literacy skills compared to the control group. The use of PBL in the experimental group facilitated independent and group-based inquiry, leading to improved problem-solving skills among students. Pratama & Zilhakim (2022) also showed that PBL had an impact on students' science literacy because the PBL model was found to be an innovative approach that encourages students to improve their thinking capacity through structured group work, which leads to the continuous development of their thinking skills. In addition, Lendeon & Poluakan's (2022) research showed that students taught using the PBL model demonstrated a higher average understanding of science literacy compared to those taught using conventional teaching methods. The PBL model helps students develop skills in critical thinking, problem solving, and application of knowledge in a practical environment, which

improves their overall understanding of scientific concepts. The PBL model emphasizes active learning and engagement, allowing students to construct their own knowledge and develop a deeper understanding of the subject matter.

PURPOSE

The focus of this research is to determine the effect of the Problem Based Learning (PBL) model on the scientific literacy abilities of class VII students in ecological material.

RESEARCH QUESTION

Does the Problem Based Learning (PBL) learning model have an effect on the growth of students' scientific literacy in class VII ecology material at SMP TP. 2023/2024?

METHOD

A quantitative research approach was used in this study. Based on positivist ideology, quantitative research is used to research certain populations or groups. The purpose of data collection is to test the hypothesis proposed through the use of research tools and quantitative or statistical data analysis Sugiyono (2019). The type of quantitative research applied is quasi-experimental and involves two classes in this study. The experimental class received learning using the Problem Based Learning (PBL) model, while the control class did not receive this treatment.

The purposive sampling technique was used in sampling for this study. The main characteristic of this method is that the sample members are purposively selected based on the research objectives (Hardan et al., 2020). The researcher and teacher worked together to determine the sample by considering the uniformity of ability in the class. As a result, the sample of this study amounted to 64 students consisting of class VII-6 which was used as a PBL learning model class, while class VII-5 was used as a control class.

This research design uses Pretest and Posttest Control Group Design. Samples were given the same pretest and posttest. Pretest is given before treatment as a basis for determining changes. Posttest is given after treatment to find out how far the final results due to treatment. The data collection technique in this study used a multiple choice science literacy test instrument of 30 items that had previously been validated.

In validating the instrument, the validity test, reliability test, question differentiator test and test the level of difficulty of the test items are carried out. To test the validity of the instrument, the instrument is first validated by expert validators, then the validated questions are then tested on non-samples. The validity test of the questions was carried out using the point biserial correlation coefficient formula with the help of the Statistical Program for Social Science (SPSS) version 22 software with a significance level of 5% ($\alpha = 0.05$) with the criteria: if rpbi> rtable, then the test instrument is said to be valid (Supardi, 2016). An assessment instrument item is said to be reliable if used to measure at different times the results will be the same (Supardi, 2016). Differentiating power of assessment instrument items, is the ability of the question to distinguish between students with high abilities (upper group) and students with low abilities (lower group) (Supardi, 2016). The level of difficulty of a question is a numerical indicator of how easy or difficult the question is. Good assessment items are items that are not simple and not too complicated (Supardi, 2016).

Data analysis techniques in the form of descriptive statistical results analysis, prerequisite tests, hypothesis testing, gain normality test, and analysis of science literacy skills. The prerequisite tests carried out in this study were normality test and homogeneity test. The normality test is used to determine whether the distribution of a

population follows a normal distribution or not. Shapiro-Wilk test is used to test the normality of data on students' science literacy skills both on pretest and posttest using the Statistical Program for Social Science (SPSS) version 22 application. If the sig price is more than α (0.05), then the data is considered normally distributed. The homogeneity test is needed to ascertain whether several groups of research data show similar variants. The provision of a significance value of α = 0.05 for the homogeneity test using SPSS software. Data variance can be declared homogeneous if the Levene statistical value is greater than 0.05.

RESULT AND DISCUSSION

In this section, we will present the results of research conducted at SMP Negeri 27 Medan with Ecology material for class VII in the 2022/2023 academic year. The two classes used as samples in this study were class VII-6 which was the experimental group that applied the PBL learning model, and class VII-5 which became the control group with a direct learning model. The research began by giving a pretest to the sample class then after the pretest results were obtained the two classes were given different treatments, then given a posttest to measure the improvement of science literacy skills.

1. Science Literacy Skills

Data on science literacy skills were collected by giving a pretest and posttest to the experimental class taught with PBL and the control class taught with direct learning. The purpose of the pretest is to determine the initial ability of students, and the purpose of the posttest is to determine the growth of students' abilities after learning using the PBL learning model. Figure 1 shows the comparison of experimental and control class science literacy skills based on pretest and posttest data.

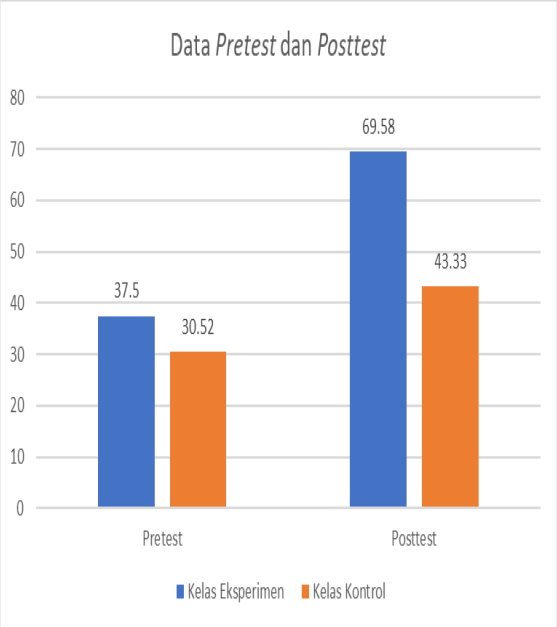

Figure 1 Comparison Diagram of Pretest and Posttest data

The average posttest score of the experimental class (69.58) was much higher than the average of the control class (43.33), as shown in the diagram. There was a difference of 26.25 points between the two scores. In addition, the data showed that in both the experimental and control courses, the average score increased from pretest to posttest findings. So, compared to the control group, overall, the improvement in science literacy in the experimental group was higher.

In the experimental class, a PBL learning model was used which began with a problem orientation, where students set a problem formulation and conducted an investigation to solve the problem. This inquiry process encourages students to analyze and connect science concepts to solve contextual problems, with teacher guidance. As this discovery process takes place, there are various impacts that affect students' science literacy skills. Students are encouraged to think critically during discussions and be active in problem solving, as well as seek information from various literatures to fulfill

knowledge needs. In addition, it teaches students how to solve problems in everyday life by utilizing science concepts.

2. Effect of PBL Model on Science Literacy Skills

a. Posttest data normality test

Table 2. Data normality test on SPSS

Tests of Normality

	Model	Shapiro-Wilk		
		Statistic	df	Sig.
Kemampuan Literasi Sains	pretest eksperimen (PBL)	.972	32	.549
	Postest Eksperimen (PBL)	.938	32	.064
	Pretest kontrol (Pembelajaran Langsung)	.955	32	.198
	posttest kontrol (Pembelajaran langsung)	.946	32	.112

a. Lilliefors Significance Correction

Based on the normality test of science literacy ability, it is known that the significance value of the experimental class pretest science literacy ability is 0.549 and the experimental class posttest is 0.064. The normality test results of the experimental class pretest data 0.549> 0.05 and experimental class posttest data 0.064> 0.05 so that the pretest and posttest data of the experimental class using the PBL model are normally distributed. The pretest and posttest science literacy skills of the control class have a significance value of 0.198 and 0.112, respectively. The normality test results of control class pretest data 0.198> 0.05 and control class posttest data 0.112> 0.05 so that the control class pretest and posttest data are normally distributed. The pretest and posttest data of the experimental and control classes came from normally distributed samples, according to the results of the SPSS normality test.

b. Homogeneity Test Result of Science Literacy Ability Score

Table 3. Homogeneity Test of Pretest data

Test of Homogeneity of Variance

		Levene Statistic	df1	df2	Sig.
Kemampuan Literasi Sains	Based on Mean	3.314	1	62	.074
	Based on Median	3.418	1	62	.069
	Based on Median and with adjusted df	3.418	1	57.986	.070
	Based on trimmed mean	3.418	1	62	.069

Table 4. Homogeneity Test of Posttest data

Test of Homogeneity of Variance

		Levene Statistic	df1	df2	Sig.
Kemampuan Literasi Sains	Based on Mean	.099	1	62	.754
	Based on Median	.057	1	62	.812
	Based on Median and with adjusted df	.057	1	61.851	.812
	Based on trimmed mean	.078	1	62	.781

Based on the homogeneity test results, the significance value for the pretest between the experimental and control classes is 0.074, while for the posttest is 0.754. The results of the homogeneity test for pretest data showed a value of 0.074 greater than 0.05, while for posttest data showed a value of 0.754 also greater than 0.05. This shows that there is uniform diversity in pretest and posttest data regarding science literacy skills between experimental classes using PBL learning models and control classes using direct learning models. Based on the homogeneity test using SPSS, it was found that the data was homogeneous. Data that has been normally distributed and homogeneous will then be used for hypothesis testing.

c. Hypothesis Test Results of Science Literacy Skills

Table 5. Hypothesis Test of Posttest Data

Independent Samples Test

	t-test for Equality of Means						
	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
						Lower	Upper
Equal variances assumed	16.425	62	.000	26.156	1.592	22.973	29.340
Equal variances not assumed	16.425	61.877	.000	26.156	1.592	22.973	29.340

Based on hypothesis testing of science literacy skills, the data obtained a significant value (2-tailed) of 0.000. So it can be stated that 0.000 <0.05 so that it can be decided that H0 is rejected and Ha is accepted. Thus it can be said that the use of the Problem Based Learning learning paradigm in class VII SMP Negeri 27 Medan has an impact on students' science literacy related to ecological material.

d. Normality-Gain

In this study, N-Gain was used to assess and measure the improvement of student learning outcomes before and after treatment. Table 6 displays the results of the N-Gain test.

Table 6. N-Gain Test Results

Kelas	*Pretest*	*Posttest*	N-gain	Criteria
VII IPA (Eksperimen)	37.5	69.58	51%	Fair
VII IPA (Kontrol)	30.52	43.33	17%	Very Low

The difference between the experimental and control classes is shown by the N-gain results. 51% is the result of N-gain which is in the sufficient category for the experimental class. While the N-gain results of the control class were in the very low category with a value of 17%. This shows that the experimental class that used the PBL learning model improved their science literacy skills more than the control class that did not use the model.

e. Analysis of science literacy skills

To determine the level of science literacy of students in both experimental and control classes, the science literacy skills were analyzed. And to see the extent of the influence of problem-based learning models on students' science literacy skills. Based on the research findings, the pretest and posttest scores were used to gather an understanding of the students' science literacy level. Data on the level of students' science literacy skills can be seen in table 7 and table 8.

Table 7. Results of students' science literacy skills based on pretest scores

Kelas	Pretest	Level	Criteria
VII IPA (Eksperimen)	37.5	2	low
VII IPA (Kontrol)	30.52	2	low

Table 8. Results of the analysis of students' Science Literacy skills based on posttest scores

Kelas	Posttest	Level	Criteria
VII IPA (Eksperimen)	69.58	4	enough
VII IPA (Kontrol)	43.33	3	less

Based on the data presented in Table 7, the average experimental class pretest score of 37.50 is at level 2 and is classified as low, the control class pretest average of 30.52 which is at level 2 which is categorized as low. Based on table 8, the average posttest of the experimental class of 69.58 is at level 4 which is in the sufficient category after the treatment with the Problem Based Learning model is applied. As well as in the control class, the average posttest value of 43.33 is at level 3 which is still categorized as less. Figure 2 shows a comparison of the experimental and control class science literacy scores.

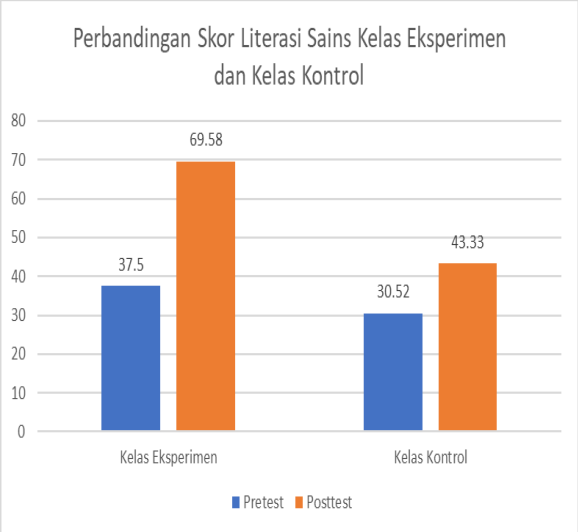

Figure 2 Comparison of science literacy scores of experimental and control classes

Based on the results of the analysis of science literacy skills, it can be seen that the significant increase is in the experimental class using the Problem Based Learning model, while in the control class using the Direct Learning model is still in the insufficient category or there is very little improvement based on the average score obtained from the pretest and posttest given. Thus, it can be said that PBL affects students' science literacy capacity, especially related to ecological content in class VII of SMP Negeri 27 Medan.

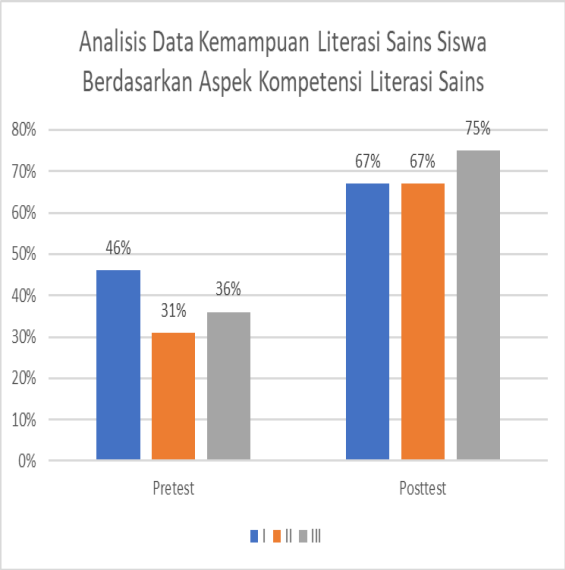

Figure 3. Analysis of Science Literacy Ability on Competency Aspects

Description:

I. Competency in Explaining Phenomena Scientifically

II. Competency to Evaluate and Design Scientific Investigations

III.Competence in Interpreting Data and Evidence Scientifically

It can be seen from the available diagrams that each aspect of the experimental class competence has increased. In the aspect of competence in explaining scientific phenomena, it can be seen that the percentage of experimental class students who managed to answer correctly in the pretest increased from 46% to 67% in the posttest. Furthermore, in the aspect of competence in evaluating and designing scientific investigations, there was a significant increase from 31% in the pretest to 67% in the posttest. In addition, in the aspect of competence in interpreting data and evidence scientifically, there was a more striking increase, reaching 75% from the pretest value which was previously only 36%.

Therefore, it can be concluded that the intervention applied to the experimental class, especially through the use of the PBL learning model, has a significant positive impact on improving students' science literacy skills in explaining phenomena scientifically, evaluating and designing scientific investigations, and interpreting data and evidence scientifically.

3. The Effect of Problem Based Learning Model on Science Literacy Skills

Students' science literacy skills were evaluated through posttest scores after learning was carried out in the experimental class using the PBL learning model, while the control class did not use the model. The pretest given to both classes resulted in low scores because students were not familiar

with the material to be studied and were not used to working on science literacy questions. After both classes received learning about the material, they were tested with a posttest to measure the improvement of science literacy skills. Based on Table 6, the experimental class showed a greater improvement in science literacy skills compared to the control class.

The findings of this study indicate that the application of the PBL model significantly improves students' science literacy skills in grade VII ecology material. Based on the results of data analysis, it was found that students' understanding of ecological concepts, problem solving skills, and critical thinking skills increased significantly after participating in learning with the PBL model. In contrast to the control group that used the direct learning model, students in the experimental group that used the PBL approach showed a greater improvement in science literacy skills.

The application of the PBL model in the classroom increases students' science literacy capacity because it encourages them to be active in solving the problems faced. The problems faced become the focus that encourages students to actively participate in discussions to find solutions. This is supported by the findings of (Landeon & Poluakan, 2022) who stated that PBL is an effective learning model to improve students' science literacy skills because it promotes higher order thinking skills and the ability to apply knowledge in real world scenarios. According to Simeru et al. (2023), the PBL model also seeks to assist students in applying their knowledge and abilities in a practical environment. PBL also aims to develop students' ability to think creatively, analytically, systematically, and logically so that they can find various alternatives in solving problems by exploring data empirically, so that their scientific attitude can grow and develop.

Learning that introduces problems that are relevant to real life can interest learners because the problems are perceived as real. This allows learners to be more involved in learning. This perspective is in line with the theory put forward by Sutrisna & Sasmita (2022) which suggests that the Problem Based Learning (PBL) model is structured to captivate student interest, thus facilitating a more realistic and interesting learning experience.

Based on Table 7 and Table 8, it can be seen that the application of the PBL model in ecology learning in the experimental class has a positive impact, this is important to improve students' science literacy skills. Through this approach, students are exposed to real-world problems that require critical thinking, collaboration and in-depth analysis. By actively participating in the problem-based learning process, students develop a deeper understanding of ecological concepts and improve their ability to interpret scientific information

Figure 3 indicates a significant increase from pretest to posttest results in the competency aspect of explaining phenomena scientifically. In the pretest, only 46% of students managed to give the right answer, but this figure increased to 67% in the posttest. This illustrates the effectiveness of the Problem Based Learning (PBL) model in facilitating the development of students' ability to provide a more scientific explanation of the observed phenomenon.

These results are in line with previous research conducted by Hermanto, et al. (2024), which states that PBL provides students with real-world problems or situations relevant to science content, allowing them to apply scientific concepts and develop analytical skills. In addition, learning with the PBL model also encourages students to actively read and discuss in groups to solve existing problems. Research conducted by Widiana et al. (2020) which

revealed the success of applying the PBL paradigm in improving student understanding through reading activities further strengthens this conclusion.

Overall, these findings indicate that the PBL model not only helps students in understanding the material in depth, but also significantly improves their ability to explain phenomena scientifically. The learning process that encourages students' active participation in group discussions to convey ideas or solutions also supports their ability to solve problems effectively.

Then, in the aspect of competence in evaluating and designing scientific investigations, there was a more significant increase. From the pretest results, only 31% of students managed to answer correctly, but this figure increased to 67% in the posttest. This increase shows that the Problem Based Learning model not only strengthens students' ability to evaluate relevance, but also to design a more systematic and efficient scientific investigation. This PBL model trains students to critically analyze information, identify weaknesses, and evaluate the credibility of sources in scientific inquiry. This finding is in line with research conducted by Alatas & Fauziah (2020) which illustrates that the structured phases of the Problem Based Learning (PBL) model, such as stimulating students to find solutions to real-world problems and implementing these solutions through experimental practices, play an important role in increasing students' proficiency in assessing and formulating scientific questions.

Finally, a significant improvement was seen in the posttest results related to the ability to interpret data and evidence scientifically. From 36% in the pretest, the figure jumped to 75% in the posttest, signifying the effectiveness of the PBL learning model in facilitating students in using data carefully and appropriate scientific evidence to support their arguments. In PBL, learners develop these skills through information gathering, critical analysis, and synthesis of data to formulate a solution to the problem at hand. This finding is in line with research conducted by Widiana et al. (2020), which showed that Problem-Based Learning (PBL) fosters a culture of thorough reading among students, enabling them to adeptly distinguish data and evidence, thus improving their analytical skills.

Overall, these data provide evidence that the implementation of PBL learning models has a positive impact on improving students' science literacy skills, especially in explaining phenomena scientifically, evaluating and designing scientific investigations, and interpreting data and evidence scientifically.

4. Factors that influence the effect of the application of the Problem Based Learning model in science learning

Although there was an improvement in students' science literacy skills after applying the PBL learning model, the improvement was still limited to the "sufficient" category with a level 4 score. One of the factors contributing to the achievement of results in students' science literacy skills is the lack of habit in using the PBL learning model. Students who are used to the direct learning approach may have difficulty in adjusting to the PBL approach. The direct learning model tends to make the teacher the main source of information, with structured teaching and clear directions. In contrast, in PBL, students are required to be active learning agents, where they must independently find, analyze, and apply information in a real context. Habits that have been embedded in previous learning experiences can be a significant obstacle in adopting new learning models such as PBL, given the changing roles of teachers and

students in the teaching and learning process.

As such, additional time and effort is required to help students adjust to the new learning model as well as develop the skills necessary to succeed in a more independent and collaborative approach to learning.

CONCLUSION

He application of the Problem Based Learning model has a significant impact on the development of science literacy skills on ecological concepts among students in class VII-6 at SMP Negeri 27 Medan, based on the research findings. This is indicated by the fact that the students of grade VII-6 who were included in the Experiment group had a significant improvement in their science literacy skills. Initially, the science literacy score obtained was 37.50 which was in the low category or level 2. The skill competency increased to level 4 after the implementation of the Problem Based Learning model with a score of 69.58 which is in the good enough range.

Based on the results and conclusions above, the researcher recommends several suggestions, among others:

1. Teachers or individuals who aspire to be educators are encouraged to explore the utilization of the Problem Based Learning model when teaching Science.
2. For students or researchers who are interested in researching this learning model, it is recommended to apply it not only on ecological material, but also on various other science materials.
3. The implementation of Problem Based Learning requires careful preparation so that the steps can be implemented systematically.

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