JPPIPA 10(11) (2024)

Jurnal Penelitian Pendidikan IPA

Journal of Research in Science Education

http://jppipa.unram.ac.id/index.php/jppipa/index

Profile of Problem-Solving Ability for High School Students: Context of Using PBL-Based Physics Learning Media on Global Warming

Anafiarsih Meliyanti[1*], Insih Wilujeng[2], Heru Kuswanto[1]

[1] Magister of Physics Education Program, Faculty of Mathematics and Natural Sciences, Universitas Negeri Yogyakarta, Indonesia.
[2] Sains Education Department, Faculty of Mathematics and Natural Sciences, Universitas Negeri Yogyakarta, Indonesia.

Received: May 30, 2024
Revised: September 06, 2024
Accepted: November 25, 2024
Published: November 30, 2024

Corresponding Author:
Ana
anafiarsihmeliyanti.2022@student.uny.ac.id

DOI: 10.29303/jppipa.v10i11.6007

Abstract: Problem-solving ability is important for students to have. This is useful for students as an effort to be able to address every problem in real life critically. This study aims to analyze students' problem-solving abilities after using physics learning media based on problem-based learning (PBL). This problem-solving ability is carried out on global warming material on the greenhouse effect. The subjects of this study were 35 students of class XI MIPA 4 at SMA N 1 Depok, Yogyakarta. The method used in this research is the descriptive analysis method. Data collection was carried out by observation and written tests. Based on the results of the analysis of students' problem-solving abilities, an average score of 75.37 was obtained in the very high category. Analysis of each indicator, including identify problems obtaining an average score of 72.22 (high category), diagnose problems obtaining an average score of 74.07 (high category), formulate strategic alternatives obtaining an average score of 79.63 (very high category). high), determine and choice strategy obtain an average score of 77.78 (very high category), and indicators evaluate the success of the strategy obtain an average score of 73.15 (high category).

Keywords: Global warming; PBL; Physics learning media; Problem-solving ability

Introduction

The development of information and communication technology has triggered a change in the learning system in schools. Basically, learning does not only aim to understand and master what and how something can happen but also provides understanding and mastery of why it can happen (Saputri & Febriani, 2017). The use of technology in learning can make it easier to transfer information so that it is well received by students. As stated by (Liana et al., 2020) technology is a cultural artifact of the current millennial generation. However, education is important in creating good human resources for future life (Dewi et al., 2023).

Learning media is a means of interaction between teachers and students in carrying out the learning process. The use of media not only makes the learning process more efficient, but also helps students understand teaching material more deeply and completely. Therefore with the media, the learning process becomes more interesting (Ali et al., 2021). There are several types of learning media, one of which is technology-based learning media. Learning material can be loaded in the form of an Android application that students can install on their smartphones.

Learning can use various learning models. The use of learning models is intended to create positive interactions between students and teachers (Lestari et al., 2022). One of the learning models is Problem-Based Learning (PBL). PBL is a learning model by presents contextual problems and encourages students to learn (Jayadiningrat & Ati, 2018). In this learning model,

How to Cite:
Meliyanti, A., Wilujeng, I., & Kuswanto, H. (2024). Profile of Problem-Solving Ability for High School Students: Context of Using PBL-Based Physics Learning Media on Global Warming. *Jurnal Penelitian Pendidikan IPA*, *10*(11), 8996–9002. https://doi.org/10.29303/jppipa.v10i11.6007

problem-solving is defined as a process or effort to complete a task or situation that really creates a problem. This model is very effectively used in the 2013 curriculum in Indonesia because it is in accordance with the demands of the curriculum, making students the center of learning (Novelni & Sukma, 2021). Problem based learning can produce better learning outcomes, such as increasing the resources of teachers and students in carrying out actions (Fathurohman & Lutfi, 2022).

Physics learning does not only contain concepts with solutions to mathematical equations but also events in the surrounding environment that require solutions with rational thinking skills. Physics learning expects students to be able to solve problems that can be applied in daily life (Yeni Nurpatri et al., 2022). A physics material that doesn't need a lot of mathematical solutions is global warming. Basic competencies in the 2013 curriculum not only require students to know about global warming but also to analyze the causes, impacts, and solutions of global warming (Ali et al., 2021). Through this material, some real problems can be presented that will be solved by students. Physics learning requires students to have problem-solving skills. Learning physics requires a good understanding of concepts, therefore students can solve problems related to their surrounding environment (Kurinta et al., 2021). In-class learning, students will work in groups to solve a problem. This can train students' ability to make decisions critically on every problem in real life. As stated by (Alatas & Fauziah, 2020) that through the PBL model, students can learn to solve problems systematically.

Problem-solving ability is important for students to have. This is useful for students as an effort to be able to address every problem in real life critically. In conditions found by (Putri et al., 2022) students are not yet accustomed to solving problems. However, according to (Aprilianti et al., 2022) some students are still lacking in solving problems because they do not understand the problem. Students' conceptual understanding is usually just memorizing existing formulas (Sri Ulina, 2022). Another study by (Duangrawa & Nuangchalerm, 2020) stated that students still had difficulty developing various criteria for evaluating solution ideas which made them unable to decide on the best solution that was right for the problem situation. Therefore, based on the statement (Rahayu & Hertanti, 2020) that students' ability to solve problems still needs to be improved, especially in planning student solutions, implementing, checking, and evaluating.

The problems found at SMA Negeri 1 Depok (Depok Public High School 1) based on the results of interviews with the Physics teacher showed that they had not used certain learning media for global warming material. Students are only given directions to study global warming material from their school books. Learning physics about global warming cannot be underestimated just because the material does not contain mathematical equations. Determination of global warming material is included in the 2013 curriculum as well as the independent curriculum, so it is important to learn. Global warming material contains an understanding of concern for the environment. Global warming material asks students to make and provide decisions regarding the problem (W. I. Putri et al., 2023).

The results of observing physics learning activities in class XI MIPA 4 SMA Negeri 1 Depok show that the teacher uses the lecture and question-and-answer method during the lesson. At the end of the lesson, the teacher gives practice questions to students based on school books. Based on this observation, the teacher has made interactions with students but learning is still teacher-centered.

PBL-based learning media is designed to make it easier for teachers and students to learn and facilitate interaction between teachers and students. Learning becomes more focused and achieves the expected goals. The use of appropriate learning media is needed in physics learning to understand the phenomena that occur (Maryani et al., 2022). Based on the description above, learning on global warming material is considered very important to be studied supported by good learning media. Therefore, the use of PBL-based learning media is expected to be able to train students' problem-solving skills related to global warming material.

Method

This research is quantitative descriptive research because the main activity in this research is to describe the problem-solving abilities of students in class XI MIPA 4 at SMA N 1 Depok. Problem-solving abilities during learning are measured by giving tests to students about global warming material. The test is in the form of description questions on the greenhouse effect sub-material. Problem-solving ability score was analyzed using descriptive statistics.

Students' problem-solving abilities will be seen based on five indicators, including identifying problems, diagnosing problems, formulating strategies, determining and determining the chosen strategy, and evaluating the success of the strategy. The interpretation of the level of problem-solving ability can be adopted from the following scoring according to (Azwar, 2018) as in Tabel 1.

Table 1. Interpretation of problem-solving abilities

Interval	Interpretation
$X \leq 25$	Very low
$25 < X \leq 42$	Low
$42 < X \leq 58$	Medium
$58 < X \leq 75$	High
$75 < X$	Very high

(Source: Azwar, 2018)

PBL has three goals including thinking and problem-solving skills; the ability to act as an adult; and independent learning abilities (Lismayana, 2019). In this research, it will be seen from the students' problem-solving abilities.

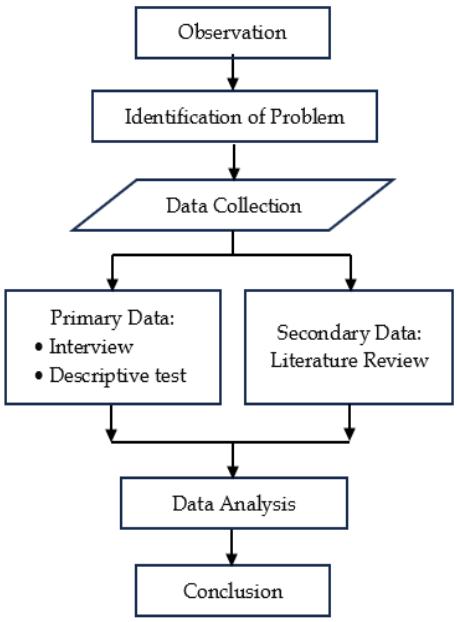

Figure 1. Study Flow Diagram

Result and Discussion

Learning is carried out by implementing PBL-based learning media in the form of a smartphone application. The initial appearance of learning media can be seen in Figure 2. In this application, students will be guided to carry out the learning steps. Students will work in groups to solve problems.

Figure 2. The main display of learning media

Learning media was created using Microsoft PowerPoint and developed with Smart Apps Creator 3 (SAC-3) software. The smart app creator application can be used to create physics learning media to improve students' understanding of concepts (Watin et al., 2023). Besides that SAC media can be used to increase student motivation in learning (Susanti et al., 2023). This application contains several menus such as learning objectives, teaching materials, learning activities, and evaluation as shown in Figure 3.

Figure 3. Display of the learning media menu

Learning tools are useful in helping teachers in carrying out learning activities more controlled and evaluated for students (Indrianti et al., 2024). Besides that learning media is made to help improve students' problem-solving abilities. This is because students' problem-solving abilities are still in the low category as stated by (Rosdiana et al., 2024) that there are two influencing factors, namely internal and external. Internal factors that come from the individual such as lack of interest and enthusiasm for learning, students' inaccuracy in reading questions and their level of self-confidence. While external factors include the learning process and the form of questions tested.

Based on the results of implementing PBL-based learning media, the average learning outcomes of students are shown in Table 2. The pretest is carried out at the beginning of learning, while the posttest is carried out at the end of learning after using PBL-based learning media.

Table 2. Scores of students' problem-solving abilities

Problem-Solving Indicator (PSI)	Scores	Category
Identify the Problem	72.22	High
Diagnose the Problem	74.07	High
Formulate Strategic Alternatives	79.63	Very high
Determine and Choice Strategy	77.78	Very high
Evaluate the Success of the Strategy	73.15	High
Average	75.37	Very high

Note: PSI-1 is identify the problem; PSI-2 is diagnose the problem; PSI-3 is formulate strategic alternatives; PSI-4 is determine and choice strategy; PSI-5 is evaluate the success of the strategy.

Table 2 shows the scores of students after learning using PBL-based media, and describes the level of students' problem-solving abilities. Nowadays, teaching materials must be able to solve problems to improve understanding and develop students' problem-solving abilities (Nuraliza & Hufri, 2023). In Table 2, it can be seen that the level of problem-solving abilities of students on the indicator of identifying problems (PSI-1) obtains an average score of 72.22 in the high category, diagnosing problems (PSI-2) obtains an average score of 74.07 in the high category, formulating alternative strategies (PSI- 3) obtaining an average score of 79.63 in the very high category, determining and determining the chosen strategy (PSI-4) obtaining a score of 77.78 in the very high category, and the indicator evaluating the success of the strategy (PSI-5) obtaining an average score of 73.15 in the high category.

Based on the results obtained, it shows that the average score of students' problem-solving ability level, namely 75.37, is already in the very high category. Because, in the learning process, students are guided by learning steps so they can find solutions well. The description of the activities of each indicator of problem-solving ability can be described as follows:

Identify the Problem

Problem identification is carried out to obtain an overview of a problem that will be discussed by students. Problem solving skills are used to solve problems that are not clear yet (Naqiyah et al., 2020). Thus students will avoid solving problems before knowing the problems that occur. The activities carried out at this stage are: (1) Reading problems in the form of discourses about increasing temperatures in Jakarta due to the greenhouse effect; (2) Identify the main points of each paragraph; (3) Write down the main problems based on the problem presented.

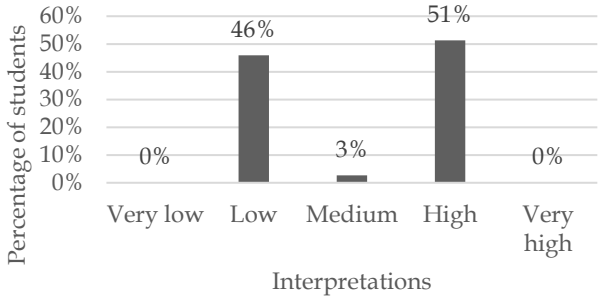

Figure 4. Percentage of students identifying problems

Based on Figure 4, there are 46% of students in the low category, 3% of students in the medium category, 51% of students in the high category, and 0% of students in the very low and very high categories, which means there are no students in that category. Students in the low category are because they don't read the discourse properly until it's finished so it's not quite right when identifying the problem in question. Meanwhile, students in the high category indicated that they could identify problems according to the discourse.

Diagnose the Problem

After identifying the main issues, at this step, students will analyze the causal factors of the problems found based on the problem presented. Most students have difficulty in solving questions because they do not understand the meaning of the questions given (Evendi et al., 2024). Students are asked to analyze at least 3 factors that cause problems.

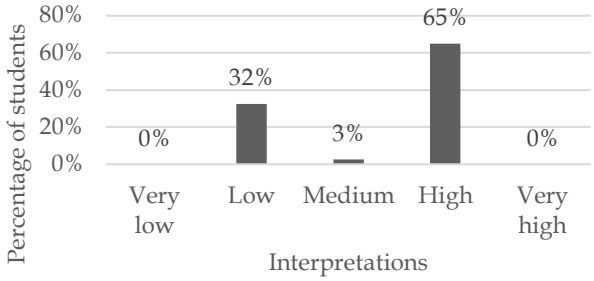

Figure 5. Percentage of students diagnosing problems

Based on Figure 5, there are 32% of students in the low category, 3% of students in the medium category, 65% of students in the high category, and 0% of students in the very low and very high categories, which means there are no students in that category. Students are in a low category because they cannot find 3 main problems that are appropriate based on the problem. In the high category, students have correctly stated 3 main problems.

Formulate Strategic Alternatives

Based on the main problems and causal factors that have been analyzed previously, then students are asked to provide several solutions or actions that can solve these problems. In this case, students are asked to provide at least 3 alternative actions to solve the problem.

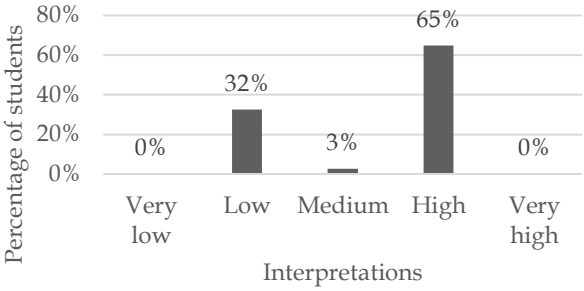

Figure 6. Percentage of students formulating alternative strategies

Based on Figure 6, there are 32% of students in the low category, 3% of students in the medium category, 65% of students in the high category, and 0% of students in the very low and very high categories, which means there are no students in that category. The percentage of the number of students on the indicator for diagnosing problems and formulating alternative strategies is the same. However, this percentage only shows the overall average of students and does not mean it is the same for each student. Students are in a low category because they cannot find at least 3 appropriate issues based on the discourse. In the high category, students have correctly stated 3 main problems.

Determine and Choice Strategy

After formulating several solutions to solving the problem, students determine the most appropriate steps to reduce the impact of the greenhouse effect which is a global warming problem. Students are asked to provide real solutions that can be implemented and the reasons for carrying out these solutions as a strategy to reduce the impact of problems.

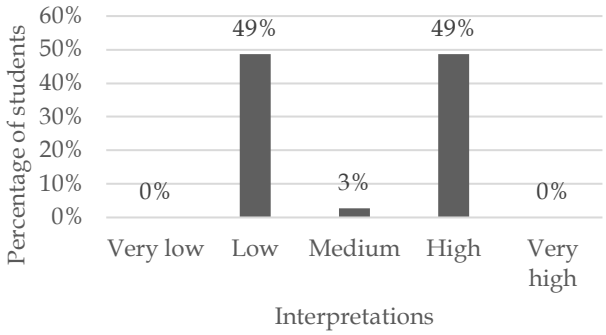

Figure 7. Percentage of students determining and setting the choice strategy

Based on Figure 7, there are 49% of students in the low category, 3% of students in the medium category, 49% of students in the high category, and 0% of students in the very low and very high categories, which means there are no students in that category. The low and high categories have the same percentage, meaning that the number of students belonging to that category is the same. In this case, the number of students who can determine the strategy is the same as students who cannot determine the right strategy based on the existing problem.

Evaluate the Success of the Strategy

This step is the final step of solving the problem. Students are asked to check the solution to the problem. Then write down what are the advantages and disadvantages of the solution or action that according to students is most appropriate for the previous problem. Students are asked to write down at least 2 advantages and disadvantages of the solution given previously.

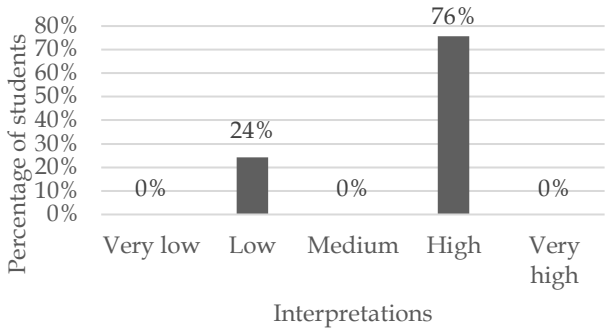

Figure 8. Percentage of students evaluating the success of the strategy

Based on Figure 8, there are 24% of students in the low category, 75% of students in the high category, and 0% of students in the very low, medium, and very high categories, which means there are no students in that category. In this result, the percentage of students in the low category is smaller than in the other 4 indicators. While the percentage of students in the high category is higher than the other 4 indicators. This means that students have provided the advantages and disadvantages of the proposed solution properly.

Based on the five graphs of each indicator that has been discussed, it can be seen the percentage of students who have understood and those who have not understood the solution systematically. However, this PBL model is considered effective for measuring students' problem-solving abilities. In line with the results of research conducted by (Firmansyah et al., 2022) that the PBL learning model can influence students' physics problem-solving abilities.

Assessing problem-solving ability with descriptive questions is considered capable of seeing the quality of students' answers compared to only giving multiple-choice questions (Aristiawan, 2022). In addition, students' problem-solving abilities through the Problem-Based Learning model can be improved (Suryani et al., 2020). Therefore, choosing the right type of questions can also assess students' abilities well.

Conclusion

Students' problem-solving abilities on each indicator include identify problems obtaining an average score of 72.22 (high category), diagnose problems obtaining an average score of 74.07 (high category), formulate strategic alternatives obtaining an average score of 79.63 (very high category). high), determine and choice strategy obtain an average score of 77.78 (very

high category), and indicators evaluate the success of the strategy obtain an average score of 73.15 (high category).

The author provides suggestions for further research in order to develop PBL-based learning media on other materials. Another consideration is about making learning media that must be considered so that the media can be used properly.

Acknowledgments
Thank you to the magister of physics education program, faculty of mathematics and natural sciences, Universitas Negeri Yogyakarta.

Author Contributions
AM contributed to product design media and data collection. IW and HK contributed to the content of product preparation and analysis of research results. All authors participated in compiling the manuscript.

Funding
This research received no external funding.

Conflicts of Interest
The authors declare that there is no conflict of interest regarding the publication of this paper.

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