JoTaLP: Journal of Teaching and Learning Physics 11, 2 (2026): 124-134
Website: http://journal.uinsgd.ac.id/index.php/jtlp/index
ISSN 2580-3107 **(online) ISSN** 2528-5505 **(print)**

[Research Article]

THE EFFECT OF THE PROBLEM BASED LEARNING (PBL) LEARNING MODEL INTEGRATED WITH SOCIOSCIENCE ON STUDENTS' INTEGRATED PROBLEM-SOLVING ABILITIES

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DOI: http://dx.doi.org/10.15575/jotalp.v11i2.57655
Received: 11 July 2026; Accepted: 26 August 2026; Published: 31 August 2026

ABSTRACT

This study aims to determine the effect of the Integrated Problem Based Learning Socioscience learning model on students' integrated problem solving abilities on renewable energy material. The study uses a quantitative approach with an experimental method. The research design uses a Quasi-experimental design with a Nonequivalent Control Group Design form. The population in this study were all students of class X. The sampling technique used purposive sampling, which selected 2 classes, namely class X-1 as the experimental class and X-5 as the control class. To obtain research data, a test instrument for students' integrated problem solving abilities was used in the form of 8 essay questions. Data processing results average control pretest obtained 51.7 and the average experimental pretest obtained 59.6. For the average control posttest results obtained 67.1 while the average experimental posttest obtained 83.8. Data analysis using descriptive and inferential with *Welch's t-test* as an alternative to the independent sample t-test with the help of the SPSS application obtained a significant post-test value of 0.000. The value of 0.000 is smaller than 0.05 (0.000 < 0.05) so it can be concluded that there is an influence of the Socioscience Integrated Problem Based Learning learning model on students' integrated problem-solving abilities. This finding shows that the Socioscience Integrated Problem Based Learning model can be an alternative in physics learning to train students' integrated problem-solving abilities.

Keywords: Problem Based Learning (PBL), Socioscience, Integrated Problem Solving Skills

How to cite: Nurfadilah, N., Novita, N., Sudirman, S., Fatmi, N., and Andriani, R. (2026). The effect of the problem-based learning (PBL) learning model integrated with socioscience on students' integrated problem-solving abilities, *Journal of Teaching and Learning Physics* ***11*** (2), 124-134. DOI: http://dx.doi.org/10.15575/jotalp.v11i2.57655

1. INTRODUCTION

Quality education is key to achieving all Sustainable Development Goals (SDGs) (UNESCO, 2017) . UNESCO emphasizes that education is the most efficient method to achieve all sustainable development goals and contribute to sustainable development. In this context, Education for Sustainable Development (ESD) is an important approach because it provides meaningful and relevant education for students to face today's challenges. ESD, as part of the 4th goal of the SDGs, is directed at integrating the principles, values, and practices of sustainable development into all aspects of education and learning (UNESCO, 2017; Suprastowo, 2024) . Through ESD, students are equipped not only with the knowledge but also with the competencies needed to contribute to realizing sustainability. UNESCO (2017) states that there are eight key competencies in advancing education for sustainable development, which include cognitive, affective, volitional, and motivational dimensions (Purnamasari & Hanifah, 2021) . One of the most crucial competencies in ESD is integrated problem-solving skills, as this competency enables students to connect various SDGs goals, understand issues holistically, consider multiple perspectives, and formulate solutions that are environmentally and socially responsible (UNESCO, 2017; Purnamasari & Hanifah, 2021) . Therefore, developing integrated problem-solving skills is a crucial requirement in learning, including physics.

The urgency of developing these skills aligns with the direction of education policy in Indonesia through the implementation of the Independent Curriculum. The Independent Curriculum is implemented as a policy to develop ESD competencies and provide schools with flexibility in developing learning according to local contexts and needs (Marlina, 2022) . Within the Independent Curriculum framework, the deep learning approach is seen as potentially feasible because it can develop students' competencies holistically, not only in cognitive aspects but also in affective and psychomotor aspects in a balanced manner (Mujtahid et al., 2025) . This suggests that learning in schools is expected to emphasize not only mastery of concepts but also encourage students to understand the meaning of learning, relate concepts to real-life situations, and use them to solve problems. Thus, the development of integrated problem-solving skills is relevant to the direction of the Independent Curriculum, which emphasizes conscious, meaningful, and enjoyable learning.

However, the implementation of the Independent Curriculum in physics learning has not fully aligned with the demands of developing ESD competencies. Initial observations indicate that physics learning still tends to be oriented towards mastering concepts and solving problems, so students do not receive optimal opportunities to develop integrated problem-solving skills. This condition is supported by (Widyaningsih et al., 2026) who stated that one of the causes of low problem-solving skills is learning that is still oriented towards conveying concepts abstractly and does not connect the material to students' real-life contexts. These learning characteristics also trigger students to act only as passive recipients of information and are less involved in the knowledge construction process, thus causing students to experience difficulty in understanding problems and being less able to solve problems comprehensively (Irfan, 2024) . As a result, in the learning process, students still experience difficulty linking physics concepts to real-life problems involving social and environmental aspects, analyzing various alternative solutions, and formulating solutions based on scientific considerations. These findings are in line with the problems found (Zulva, 2025) that high school students still experience difficulties in explaining and linking physics concepts to real situations in everyday life, this is shown by students' tendency to understand problems comprehensively.

The implementation of student-centered learning models, such as discovery learning and problem-based learning that have been implemented have also not provided optimal results. This condition is thought to be related to the use of learning problems that are not sufficiently contextual, so that the process of analysis and linking concepts is shallow, students tend to be oriented towards the final answer, and have not been able to explain the relationship between the material and the problem comprehensively. The presentation of problems that tend to be academic (book-oriented) and do not refer to problems close to everyday life causes students to rarely have the opportunity to develop their reasoning skills and have difficulty in practicing outside the classroom (Kaseger et al., 2024) . These findings confirm that physics learning still needs to be directed towards more meaningful and contextual learning experiences in order to facilitate the development of integrated problem-solving skills optimally.

Based on these conditions, a learning model is needed that not only places students at the center of learning activities but also presents contextual, meaningful, and life-affirming problems, thereby encouraging students to actively understand the problem-solving process, connect physics concepts with social issues in their environment, and analyze problems thoroughly before determining solutions. One alternative that can be used to address these needs is the Problem-Based Learning (PBL) model, because this model builds students' conceptual understanding through contextual problems (Azizah, 2021) and involves students actively, collaboratively, systematically, critically, logically, and analytically in formulating solutions to problems. This helps them understand physics concepts more deeply through involvement in the scientific investigation process and can be applied to various physics topics. (Azhari, 2024; Aulia et al., 2022; Fadilah et al., 2025) . However, for problem-based learning to be truly close to students' lives and capable of developing integrated problem-solving skills, the use of problems in PBL needs to be strengthened with the integration of socioscience. Socioscience presents real problems that are relevant to everyday life, have pros and cons, and are related to social problems in society, so that it not only develops critical thinking skills but also encourages students to connect scientific concepts with social contexts more comprehensively (Siska et al., 2020 ; Huda, 2024). In essence, socioscience serves as a bridge between physics content and the goals of Education for Sustainable Development (ESD), which ensures that learning is not only scientifically accurate but also grounded in social aspects (Novita et al., 2025) .

Renewable energy material is considered suitable for use in this study because it is closely related to regional potential, students' daily lives, and sustainability issues. In this material, learning outcomes not only require students to understand alternative energy but also encourage them to play an active role in solving problems on local and global issues. In line with this, Education for Sustainable Development (ESD) encourages students to understand and overcome real challenges around them, think critically, and actively participate in finding innovative solutions (Vioreza et al., 2023) . In this context, integrated problem-solving skills are important because they train students to analyze problems comprehensively by considering various perspectives and the impact of the solutions taken, thus supporting the formation of individuals who think critically, systematically, and responsibly towards sustainability. These problems become increasingly relevant when linked to various environmental phenomena close to students' lives in Aceh, such as flash floods, the drying of fishery and agricultural products, and waste problems that impact community activities and the environment. These phenomena can serve as a context for physics learning to connect concepts with real-world problems and encourage students to consider scientific, social, and environmental aspects in formulating solutions.Therefore, the application of Problem Based Learning integrated with socioscience in renewable energy material is considered relevant to facilitate students building knowledge based on real facts and phenomena while developing integrated problem-solving skills . Based on this description, this study was conducted to examine the effect of the Problem Based Learning model integrated with socioscience on students' integrated problem-solving skills.

Based on the description, empirical studies are still needed regarding the application of Problem Based Learning integrated with socioscience in physics learning, especially in relation to students' integrated problem-solving abilities in renewable energy material. Therefore, this study was conducted to analyze the effect of the application of Problem Based Learning integrated with socioscience on students' integrated problem-solving abilities and to provide empirical evidence regarding the implementation of the model in physics learning that supports the achievement of Education for Sustainable

Development (ESD) competencies. The results of this study are expected to enrich studies on the integration of socioscience in Problem Based Learning and become a reference for the development of physics learning that is more contextual and aligned with the development of competencies needed in sustainable development.

Although socioscience-integrated PBL has been widely applied to develop critical thinking, problem-solving, and scientific literacy skills, studies on its influence on integrated problem-solving skills as ESD competencies in physics learning are still limited, especially on renewable energy materials linked to contextual problems in students' environments. Based on this gap, the novelty of this study lies in the integration of PBL and socioscience to develop integrated problem-solving skills within an ESD framework through renewable energy materials. This integration directs students to understand problems, consider various perspectives, and formulate solutions by considering scientific, social, and environmental aspects. Therefore, this study was conducted to analyze the influence of socioscience-integrated PBL on students' integrated problem-solving skills in renewable energy materials.

2. METHOD

This study used a quantitative approach with an experimental method. The research design used was a Quasi-Experimental Design with a non-equivalent control group design . In this research design, the sample was divided into two groups: the experimental group and the control group.

Table 1. Research Design.

Class	Pre-Test	Treatment	Post-test
Experiment	O_1	X	O2
Control	O_1	Y	O2

(Sugiyono, 2019) .

The population in this study were all students of class X divided into 6 classes. The sampling technique used a purposive sampling method, so that 24 students from class X-1 were obtained as the experimental class and 26 students from class X-5 as the control class by considering the characteristics of students in each class and seen from the abilities of both classes which were almost balanced. The experimental group will receive treatment with a problem-based learning model integrated with socioscience, while the control group will be given treatment with a direct instruction learning model. In this study, there are two variables used, namely integrated problem-solving ability as the dependent variable and the problem-based learning model integrated with socioscience as the independent variable.

Data collection in this study was conducted using a test method using an essay test consisting of 8 questions that had been selected according to the criteria for analyzing the instrument test results by paying attention to indicators of integrated problem-solving ability, validity tests, reliability, difficulty levels, and test of question discrimination. The test was conducted twice: an initial test (pre-test) and a final test (post-test). The following are the instrument indicators used in the study.

Table 2. Test Instrument Indicators

Integrated Problem Solving Ability Indicator	Question Indicator	Cognitive Level	Number Question
Applying different problem-solving frameworks to complex sustainable development problems.	Identifying energy problems and analyzing natural resource potential	C4	1
	Using data to estimate total CO2 emissions	C4	2
	Providing innovative solutions	C6	3
Developing viable, inclusive and equitable solutions.	Choosing solutions to maximize total clean energy	C4	4

	Design and explain solutions taking into account technical and environmental aspects.	C6	5
	Analyzing aspects of social and economic justice	C4	6
Leveraging the right competencies to solve problems.	Calculate and evaluate using physics principles	C3	7
	Calculating emission reductions from clean energy.	C3	8

Adaptation: (UNESCO, 2021)

This study employed two data analysis techniques: descriptive analysis and inferential analysis. Descriptive analysis was conducted to provide a general overview of students' integrated problem-solving abilities through the calculation of average scores using Microsoft Excel. The results of the data processing were then presented in the form of diagrams and descriptive descriptions to demonstrate students' achievement in integrated problem-solving abilities after participating in the learning process. To view the average pretest and posttest scores for each class, the following formula can be used:

$$M x = \frac{\sum X}{N} \times 100\%$$

(Betriami & Efrizon , 2022)
Information:
Mx : Average learning completion
∑X : Total scores obtained by all students
N : Number of students who took the test

Table 3 Average Assessment Criteria for Integrated Problem Solving Ability.

No	Score	Information
1.	90% - 100%	Very good
2.	80% - 89%	Good
3.	75% - 79%	Enough
4.	55% -74%	Not enough
5.	0% - 54%	Very less

(Betriami & Efrizon, 2022)

Table 4 Classical Learning Completion Criteria.

No	Score	Information
1.	90% - 100%	Completed
2.	80% - 89%	Completed
3.	75% - 79%	Completed
4.	55% -74%	Not Completed
5.	0% - 54%	Not Completed

Adaptation: (Betriami & Efrizon, 2022)

The score value obtained based on the indicators will be analyzed using the following formula:

$$P = \frac{f}{N} \times 100\%$$

Adaptation: (Betriami & Efrizon, 2022)
Information:
P : Final Value
f : Score Acquisition
N : Maximum Score

Table 5. Assessment Criteria for Integrated Problem Solving Ability Indicators.

Score	Criteria
81%-100%	Very Good (SB)
61%-80%	Good (B)
41%-60%	Enough (C)
21%-40%	Low (R)
0%-20%	Very Low (SR)

(Betriami & Efrizon, 2022)

Meanwhile, inferential analysis was conducted on the post-test data which included normality test using Shapiro - Wilk (Sugiyono, 2023) , homogeneity test using Levene's Test (Fitri et al., 2023) , and hypothesis testing using Welch's t-test (Malik & Koskan, 2023; Field, 2013)

3. RESULTS AND DISCUSSION

3.1 Results

3.1.1 Descriptive Analysis Results

1) Results of Test Instrument Analysis

The results of the analysis of the test question instrument are shown in Table 6 as follows:

Table 5the Instrument Analysis Test.

No	Validity		Reliability	Difficulty Level		Distinguishing Power		Integrated Problem Solving Ability Indicator
	Value	Description		Value	Description	Value	Description	
1.	0.55	Valid	0.852	0.65	Easy	0.21	Fair	Applying different problem-solving frameworks to complex sustainable development problems.
2.	0.76			0.55	Average	0.58	Good	
3.	0.67			0.41	Average	0.17	Bad	
4.	0.70			0.57	Average	0.58	Good	Developing viable, inclusive and equitable solutions.
5.	0.76			0.42	Average	0.29	Fair	
6.	0.86			0.43	Average	0.42	Good	
7.	0.62			0.56	Average	0.38	Fair	Leveraging the right competencies to solve problems.
8.	0.71			0.6	Average	0.46	Good	

By considering the integrated problem-solving ability indicator aspects, valid questions, reliability, varying levels of difficulty, and good discriminating power, the eight questions were assessed as the items that best met the criteria for a good instrument. Therefore, these eight questions were selected and used as the research instrument because they were considered more representative in measuring students' problem-solving abilities than other item.

2) Average Results of Integrated Problem Solving Ability
The results of the recapitulation of pretest-posttest values for each class obtained the lowest value, highest value, and average value as shown in the data summary in table 7 below.

Table 7. Summary of Pretest-Posttest Data for the Experimental Class and Control Class.

No	Data Centralization	Pretest		Posttest	
		Experiment	Control	Experiment	Control
1	The highest score	77.5	86.5	100	97
2	Lowest Value	43	34.75	70.75	39
3	Average value	59.6	51.7	83.8	67.1

Based on the results of the pretest and posttest conducted in both classes, the results of student answers in the pretest in the experimental class with an average score of 59.6 and in the control class with an average score of 51.7. The posttest score in the experimental class obtained a score of 83.8 while in the control class obtained a score of 67.1. Below is a graph of the average pretest and posttest scores of students in the experimental and control classes.

Before conducting the hypothesis test, a prerequisite analysis test was first carried out, including a normality test and a homogeneity test on the experimental and control class data.

3.1.2 Inferential Analysis Results
1) Pretest and Posttest Normality Test
The following is the normality table data for the pretest-posttest of the experimental class and the control class.

Table 8. Results of the Pretest-Posttest Normality Test for the Control and Experimental Classes.

Variables	Class	Pretest/Posttest	Shapiro-Wilk test		
			Statistics	df	Sig.
Integrated problem solving skills	Control	Pretest	0.922	26	0.050
		Posttest	0.956	26	0.394
	Experiment	Pretest	0.944	24	0.197
		Posttest	0.958	24	0.317

Based on the data in table 6 above, the results of the normality of the pretest instrument in the control class obtained a significance value of 0.050 ≥0.05 indicating that the pretest was normally distributed (Field, 2013) . In the pretest of the experimental class, a significance value of 0.197 was obtained with the same significance level, so it can be concluded that the pretest data in the experimental class was also normally distributed. While the posttest values in both classes, both the experimental and control classes, both obtained values greater than the significance level of 0.05. Where the posttest significance value in the experimental class was 0.317 while the control class significance value was 0.394. So from the explanatory data above, it can be seen that the normality test on the pretest-posttest results was normally distributed because the significance value in each class met the significance level of 0.05.

2) Pretest-Posttest Homogeneity Test
The homogeneity test was conducted using the SPSS application with a significance level of ≥ 0.05 to determine whether the subjects were homogeneous or not. The results of the homogeneity test for the pretest-posttest of the experimental class and the pretest-posttest of the control class on integrated problem-solving abilities can be seen in the following table:

Table 6of Homogeneity Test.

Information	Levene's Statistics	df1	df2	Sig.
Pretest	0.581	1	46	0.450
Posttest	6,437	1	46	0.014

Based on the average homogeneity table data, the homogeneity test was obtained in the table with a significant value on the pretest instrument of 0.450 while on the posttest instrument it was 0.014. Where the significant value ≥ 0.05 means that the pretest value is homogeneously distributed but not homogeneously distributed on the posttest.

3) Hypothesis Testing
Based on the results of the prerequisite test, it shows that the pretest and posttest data are normally distributed, but the posttest data are not homogeneously distributed. The hypothesis test that Parametric analysis was carried out using the Welch's t-test , which is an alternative to the Independent Sample t-test (Malik & Koskan, 2023; Field, 2013) . This hypothesis testing was carried out using IBM SPSS Statistics software version 24.

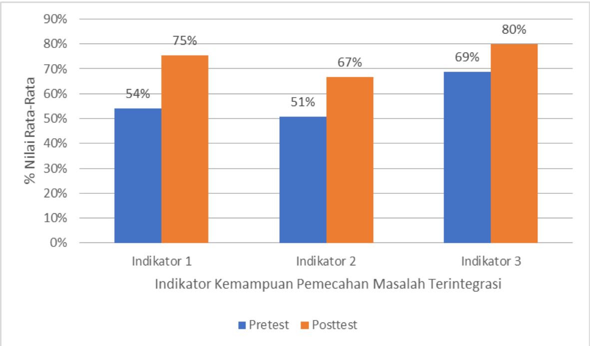
Table 10. Results of the Independent Simple t- test.

		T-Test for Equality of Means		
		Sig.(2-tailed)	Mean Difference	Standard Error Difference
Integrated problem solving skills	Equal variance assumed	0.000	-16.10016	3,567
	Equal variance not assumed	0.000	-16.10016	3,490

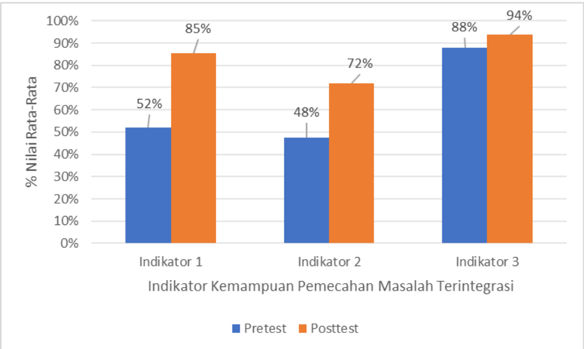
Based on the table above, the calculated significance value obtained in the Equal variance not assumed section is 0.000, which is smaller than 0.05 ($p < 0.05$). Thus, H_0 is rejected and H_a accepted or there is an influence of the integrated socioscience problem based learning model on students' integrated problem solving abilities.

3.1.3 Results based on Integrated Problem Solving Ability Indicators

The results of the average pretest-posttest scores for each class based on the integrated problem-solving ability indicators consisting of: (1) Applying different problem-solving frameworks for complex sustainable development problems, Indicator (2) Developing feasible, inclusive and fair solutions ,indicator (3) Utilizing appropriate competenci es to solve problems can be seen in Figure 1. Graph of the percentage value of each problem-solving ability indicator for the Control class. and Figure 2. Graph of the percentage value of each indicator of problem-solving ability in the experimental class. following.



Picture 1. Graph of the percentage value of each indicator of problem solving ability in the control class.



Picture 2. Graph of the percentage value of each indicator of problem-solving ability in the Experimental class.

Based on Figure 1 and Figure 2, changes were obtained for each indicator of integrated problem-solving ability in each class. The largest change in value in both classes occurred in indicator (1), with a range of 21% in the control class and 33% in the experimental class.

3.2 Discussion

The pretest results in the experimental class obtained an average value of students' integrated problem-solving ability of 59.6 while the posttest in the experimental class obtained a value of 83.8. In the control class, the average pretest value was 51.7, while the posttest value in the control class obtained a value of 67.1. Based on the results of the pretest and posttest of students' integrated problem-solving ability in both classes, the highest value of students' integrated problem-solving ability was found in the experimental class. This is in line with research (Herlinda et al., 2021; Habati et al., 2025 ; Putra & Yulita, 2021) which shows that there is a significant positive influence between the Problem Based Learning learning model on problem-solving abilities. This is proven by the posttest scores using the socioscience integrated PBL model being higher than the posttest scores using the socioscience integrated PBL model. Direct Instruction.

Furthermore, this difference was also evident in the scores obtained for each indicator of integrated problem-solving skills in both classes. In the experimental class, the improvement demonstrated that the process of problem identification, information search, discussion, and solution development in integrated problem-based learning (Problem-Based Learning) in Socioscience helped students connect learned concepts to real-life situations. Meanwhile, the change in scores in the control class indicated that Direct Instruction learning also helped students understand the material and apply it to problem-solving, although the achievement was still lower than in the experimental class.

These achievements were achieved through eight descriptive questions structured based on three main indicators of integrated problem-solving skills within the ESD framework: using appropriate competencies to solve problems, applying problem-solving frameworks, and developing feasible, inclusive, and equitable solutions. Grouping questions based on these three indicators forms the basis for presenting integrated problem-solving skills achievements in the graph.

These differences in achievement are related to the treatment process in the experimental class that uses contextual socioscience problems, such as the issue of flooding in Aceh, the process of drying agricultural and fishery products during the rainy season, and the problem of waste related to renewable energy and its impact on people's lives and the environment. Through these problems, students are guided to analyze the problem, consider various perspectives, and formulate solutions based on scientific, social, and environmental aspects. The context of the problem that is close to the students' lives supports their involvement in the problem-solving process more comprehensively .

Graph of the percentage value of each indicator of problem-solving ability in the Control class The difference in integrated problem-solving abilities in the experimental class was also caused by students' active involvement in the learning process, which aligns with the characteristics of the problem-based learning model , which places problems as the primary focus of learning. This aligns with the opinion expressed by Ananda (2025) that problem-based learning is a learning model that actively engages students in the learning process, thereby influencing students' problem-solving abilities. This learning maximally involves all students' abilities in an active, collaborative, and student-centered learning process to search for and investigate something systematically, critically, logically, and analytically, enabling students to formulate solutions to problems with confidence in developing problem-solving abilities (Azhari, 2024; Aulia et al., 2022) . Furthermore, the integration of socioscience issues into learning significantly contributes to improving students' problem-solving abilities. Socioscience issues connect scientific concepts with social, economic, environmental, and technological aspects relevant to everyday life. This requires students not only to solve problems but also to understand the social, moral, and scientific impacts of the issues under consideration (Wardana, 2024) .

These results indicate that the integration of the Problem Based Learning model with a socioscience context is able to create a learning experience that not only encourages students to understand concepts, but also trains them to analyze problems, consider various alternative solutions, and make decisions relevant to real situations. Therefore, the differences in integrated problem-solving abilities found in this study are the result of the integration between the student-centered learning process, active engagement during learning, and the use of socioscience issues such as the Aceh flash flood as a meaningful learning context. Thus, the findings of this study further confirm that the application of the Problem Based Learning model integrated with socioscience has contributed to improving students' integrated problem-solving abilities.

4. CONCLUSION

Based on the research results obtained, it can be concluded that there was an increase in students' integrated problem-solving abilities in the experimental class after the implementation of the *Problem Based Learning* (PBL) model integrated with socioscience. This finding indicates that the *Problem Based* Learning model combined with socioscience issues has an effect on students' integrated problem-solving abilities. Through the implementation of this model, students are encouraged to be more active in the learning process through activities to identify problems, analyze information, develop various alternative solutions, and determine appropriate solutions based on scientific and social considerations. These activities facilitate students in developing problem-solving abilities more comprehensively. However, the arrangement of these activities requires good classroom management so that each stage of the PBL can be implemented according to the learning plan. Therefore, teachers need to manage time, activities, and student involvement optimally so that all PBL activities integrated with socioscience can take place effectively and achieve learning objectives. Thus, the *Problem Based Learning model* integrated with socioscience can be considered as an effective learning alternative to optimally develop students' integrated problem-solving abilities.

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