Sosioedukasi
JURNAL ILMIAH ILMU PENDIDIKAN DAN SOSIAL
ISSN: 2086-6135 E-ISSN: 2541-612x
Volume 14 No. 3. September 2025 https://ejournal.unibabwi.ac.id/index.php/sosioedukasi/index

# THE EFFECT OF THE PROBLEM BASED LEARNING (PBL) LEARNING MODEL ON THE PROBLEM-SOLVING ABILITY OF THE HUMAN RESPIRATORY SYSTEM MATERIAL IN STUDENTS OF SMA NEGERI 1 BAHOROK

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**ARTICLE HISTORY**
**Received** : 23-06-2025
**Revised** : 30-07-2025
**Accepted**: 03-08-2025

**KEYWORDS**
Problem Based Learning;
Problem-Solving;
Ability;
Human Respiratory System:
Biology Learning.

**ABSTRACT**
This study aims to determine the effect of the Problem Based Learning (PBL) model on students' problem-solving abilities in the topic of the human respiratory system at SMA Negeri 1 Bahorok. The research employed a quantitative approach using a quasi-experimental design with a pretest-posttest control group design. The sample consisted of 60 11th-grade science students divided into two groups: an experimental class (using PBL) and a control class (using conventional learning). The instrument used was an essay test consisting of 10 questions. The results showed a significant difference between the posttest scores of the experimental and control classes. The average posttest score of the experimental class was 95.00, while the control class scored 63.33. The Independent Samples t-Test indicated a significance value of 0.000 (< 0.05), confirming that the PBL model significantly influenced the improvement of students' problem-solving abilities. Therefore, the PBL model is effective in enhancing students' problem-solving skills, particularly in biology lessons on the respiratory system.



## INTRODUCTION

Education is one of the effective methods to create a quality young generation. Through education, students are assisted in achieving their goals, developing interests, talents, and forming behaviors that are beneficial to their lives.The development and advancement of technology in the 21st century requires every teacher to encourage students to be able to learn independently, collaborate, think creatively, and critically in solving various problems. Therefore, education is considered good if it is able to equip students with skills that can be applied in daily life and be able to face and solve all problems in various situations and conditions. (Fatianda & Badrun, 2022) ( Faikoh & Anwar, 2025; Marpaung et al., 2024) (Siagian, 2016)

The learning process in the classroom does not always go well and sometimes produces suboptimal results. This is due to various obstacles and challenges in learning, such as the use of inappropriate learning models and media to support student development, especially in improving their ability to solve problems. Problem-solving skills are a person's skill in using complex logic to solve a problem. This is done by gathering facts, analyzing the information that has been obtained, devising various methods to find missing parts, and choosing the most effective way to achieve a goal. ( Nurzaidah & Ruslaini , 2025) (Nurhalisa et al., 2024)

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(Akuba et al., 2020)

Based on a survey conducted by the *program for International Student Assessment* (PISA) in 2022, it is known that despite the decline in scores internationally due to the pandemic, Indonesia's ranking in problem-solving skills, especially in mathematical literacy, has increased. Indonesia has increased 5-6 positions compared to PISA 2018, although science literacy scores have decreased. This decline in score was influenced by (Anto et al., 2024) *learning loss* due to school closures during the pandemic, and the PISA 2022 results reflect the condition of education two years ago. PISA measures students' ability to solve problems through internationally standardized questions. (Azhar et al., 2023)

Therefore, it is important for educators to choose a learning model that can facilitate students in developing these skills. One of the learning models that is considered effective in developing problem-solving skills is *Problem Based Learning* (PBL). (Putri et al., 2023)

*Problem Based Learning* (PBL) is a learning model that uses real-world problems as a context for students to learn how to solve problems, develop critical thinking skills. The Problem Based Learning model is a student-focused learning approach, encouraging active learning, improving problem-solving skills, and deepening understanding and application of knowledge in real-world situations. ( Nafisah & Ratnasary , 2020) (Fredrikson et al., 2015)

Through PBL, students are faced with problem situations that require not only conceptual understanding, but also the skills to find solutions through analysis, discussion, and collaboration. This model develops critical skills, problem-solving, and communication. Students who participate in problem-based learning tend to have the understanding learned and are better able to recognize and solve the problems they face. This PBL learning model has many advantages in developing student competencies, especially in critical thinking, creativity, and being able to solve various problems faced. (Djati et al., 2023) (Nurhaliza et al., 2024) (Hidayani et al., 2025)

In Biology learning at the high school level, especially at SMA Negeri 1 Bahorok, there is material about the human respiratory system. This material is one of the topics that requires an in-depth understanding of the functions of the body's organs, the biological processes that occur, and the impact of various diseases that attack the respiratory system. This understanding is also the foundation for students to develop problem-solving skills related to the material of the human respiratory system. Although this material is very important, many students have difficulty understanding it as a whole, so this can affect the level of students' problem-solving skills in solving a problem. This difficulty is due to the complexity of the material that includes various scientific concepts, such as the structure and function of respiratory organs, as well as the influence of external factors, such as pollution or infection on the respiratory system. Another difficulty is also caused by the lack of precision in choosing a learning model that can facilitate students in developing problem-solving skills.

Students in conventional learning tend to focus more on memorizing the material than understanding the relationships between concepts. Therefore, the application of Problem Based Learning (PBL) to the human respiratory system material can help students understand the material better and develop their ability to solve problems related to real situations, such as diseases of the human respiratory system. In the human respiratory system material, students may be given problems related to disorders or diseases of the respiratory system, such as asthma or pneumonia, and asked to analyze the exact causes and solutions.The application of PBL in this context is expected to improve students' understanding and their ability to solve problems more effectively. (Djati et al., 2023) (Ramadani & Alimah, 2022)

reported that there was a positive influence of the ( Simatupang & Ionita , 2020) *Problem Based Learning model* on students' problem-solving ability on environmental pollution materials in class X MIA SMA Negeri 1. The results of his research stated that one of the learning models that is considered effective in training and developing problem-solving skills both in the school environment and in the surrounding environment is *Problem Based Learning* (PBL). Furthermore, it is also reported that the ( São Paulo & São Paulo , 2023) *Problem Based Learning* learning model is effective in improving students' problem-solving skills, especially in biology learning. The results of his research stated that through a literature review of 15 recent studies, it indicated that students who were taught with PBL had better problem-solving skills compared to conventional methods. This is the basis for the implementation of research that examines the problem-solving ability of respiratory system materials at SMA Negeri 1 Bahorok by applying *a Problem Based Learning* (PBL) based learning model.

Students who are taught with PBL are expected to demonstrate a deeper understanding of respiratory

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system material and be more skilled in solving problems related to the topic. This study aims to examine the influence of the application of (Susilowati et al., 2017) *the Problem Based Learning model*

(PBL) on students' problem-solving abilities in the material of the human respiratory system. The application of this model is expected to improve students' understanding of the material, as well as their ability to analyze and solve problems related to the respiratory system.Thus, the results of this research are expected to make a positive contribution to the development of more effective learning models in the classroom.

## METHOD

**Types of Research**

Quantitative research is a research approach that uses numerical and statistically analyzed data to test hypotheses. The purpose of the study was to determine the influence of the Problem Based Learning (PBL) model on students' problem-solving skills. The approach used is (Abdullah, 2022) *Quasi Experimental Design*. *A quasi-experiment* is an experiment that involves a control group but does not fully control all outside variables that could affect the results. The research design is *Pretest-Posttest Control Group Design*. This design involved two groups (experiment and control) that were given pre- and *post-treatment* tests to see changes due to treatment, respectively.

**Research Design**

The design applied is *a pretest-posttest control group design* (Abdullah, 2022) . This design can be described as follows:

| | | | |
|---|---|---|---|
| A | $O_1$ | X | $O_3$ |
| A | $O_2$ | C | $O_4$ |

Information:
A : random sampling
O1 : *pre-test* experimental class
O2 : *pre-test control class*
O3 : Experimental class *Post-test*
O4 : *post-test control class 1*
X : PBL-based Learning Model
C: control of treatment using conventional learning

**Population and Sample**

*Population*: Students of grade XI Science of SMA Negeri 1 Bahorok. Populations are the entire groups that are the target of the research and have relevant characteristics. (Akbar et al., 2023)
Sample:

1. XI Science 2 → Experimental class (30 students)
2. XI Science 3 → Control class (30 students)

A sample is a part of the population that is used as a research subject to represent the whole. The technique used is *Cluster Random Sampling*. Sampling techniques based on randomly selected groups/classes

**Instrument Type: Description test (essay)**

Instruments are tools for collecting data, in this case in the form of essay questions. In this study, the description test includes, the number of questions is 10 items, the purpose of the question is *the pretest* to measure the initial ability, while *the posttest* is to measure the effect after treatment. Then the validity of the content is carried out based on the grid and reviewed by expert lecturers. The validity of the content ensures that the questions created are in accordance with the objectives and learning indicators.

**Data Collection Techniques**

Test: *Pretest* and posttest

a. The test is used to measure problem-solving skills before and after learning. Observation:
   Observation sheet of teachers → observing teaching activities
   Student observation sheet → observing learning and cooperation activities
b. Observations are carried out to observe behavior and learning processes.
c. Documentation: Documentation includes school data, student lists, and other administrative evidence.

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**Research Procedure**

The Preparation Stage includes initial observation, determining the population, compiling lesson plans, MLKPD, grids, questions and instrument tests with expert lecturers. Then the implementation stage includes the provision of pretests, the implementation of PBL learning in experimental classes and conventional learning in the control class and the administration of *posttests*. Finally, the completion stage includes data analysis, concluding the results of the research. This research procedure describes the systematic stages in carrying out research from start to finish.

**PBL Model Syntax**

Furthermore, the learning process of human respiratory system material is given a student worksheet (LKPD) which contains learning activities in accordance with the PBL syntax. The syntax of PBL in learning can be seen in the table (Asrulla et al., 2023)

**Table 1 Problem Based Learing Syntax**

| Stages | Teacher Activities |
|---|---|
| Stage 1<br>Student orientation on the problem | The teacher explains the learning objectives, explains the logistics needed, proposes a phenomenon or demonstration or story to raise a problem, motivates the student to get involved in the solution of the chosen problem. |
| Stage 2<br>Organizing students to learn | The teacher helps students to define and organize study tasks related to the problem. |
| Stage 3<br>Guiding research Individuals and groups | The teacher encourages students to gather appropriate information, carry out experiments, to get explanations and problem-solving. |
| Stage 4<br>Develop and present works | The teacher assists students in planning and preparing appropriate work such as reports, as well as helping them to share assignments with their friends. |
| Stage 5<br>Analyze and evaluate processes Troubleshooting | The teacher helps students to reflect or evaluate their investigations and the processes they use. |

*(Source: Amalia's Thesis)*

**Data Analysis Techniques**

Statistical Analysis Requirements Test includes:

a. Normality Test,
   To find out if the data is normally distributed use the Kolmogorov-Smirnov or Shapiro-Wilk test with SPSS25.0. It can also be done to find out whether the distribution in the sample data is normal or not.
b. Data Homogeneity Test
   To find out if the variance between groups is homogeneous, use the Levene test.
c. Hypothesis Test
   To determine the influence of the Project Based Learning model on students' communication and critical thinking skills, using SPSS 25.0 was used:
   - T-test (Independent Sample t-Test) when the data is normal and homogeneous.
   - Mann-Whitney test when data is abnormal or inhomogeneous

## RESULTS AND DISCUSSION

**Result**

**1. Descriptive Statistics of Pretest and Posttest Experimental Class XI Science 2 and Control Class XI Science 3**

**a. Experimental Class XI Science 2**

The following is a table of descriptive statistics for pretset and posttest for the XI Science 2 experimental class:

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**Table 2. Descriptive Statistics of Experimental Classes (XI Science 2)**

| Statistics | Pretest | Posttest |
|---|---|---|
| N | 30 | 30 |
| Correspondence | 39,33 | 95 |
| Standard Deviation | 16,40 | 5,48 |
| Minimum Score | 10 | 80 |
| Maximum Value | 100 | 100 |

Based on Table 2, it was obtained that the average *pretest* score of experimental class students was 39.33 with a standard deviation of 16.40, a minimum score of 10, and a maximum of 100. After being treated using the *Problem Based Learning* (PBL) learning model, the average *posttest score* increased to 95.00 with a standard deviation of 5.48, a minimum score of 80, and a maximum of 100. This improvement indicates that there is an increase in problem-solving ability after the implementation of the PBL model.

**b. Control Class XI Science 3**

The following is a table of descriptive statistics for pretset and posttest for the XI Science 2 experimental class:

**Table 3. Descriptive Statistics of Control Class XI Science 3**

| Statistics | *Pretest* | *Posttest* |
|---|---|---|
| N | 30 | 30 |
| Correspondence | 31,33 | 63,33 |
| Standard Deviation | 17,11 | 17,61 |
| Minimum Score | 0 | 30 |
| Maximum Value | 80 | 90 |

Table 3 shows the results of descriptive statistics for the control class. The *average student pretest was 31.33 with a standard deviation of 17.11, a minimum score of 0, and a maximum of 80. After participating in conventional learning,* the average score of students increased to 63.33 with a standard deviation of 17.61, a minimum score of 30, and a maximum of 90. Although there was an increase, the increase was not as large as that which occurred in the experimental class.

From the two descriptive statistical tables, the average *posttest of the* experimental class was much higher than that of the control class (95.00 vs. 63.33), which shows the potential influence of the PBL model on students' problem-solving ability.

**2. Test Statistical Analysis Requirements**

**a. Normality Test**

The normality test was carried out to find out whether the communication ability data in the experimental class and the control class were normally distributed or not. The normality test was carried out using *the Shapiro-Wilk Test*, because the sample count was less than 50 students per group. The following are the results of the normality test of problem-solving ability data:

**Table 4. Normality Test**

**Tests of Normality**

| | Kolmogorov-Smirnova | | | Shapiro-Wilk | | |
|---|---|---|---|---|---|---|
| | Statistics | Df | Sig. | Statistics | Df | Sig. |
| pretest_kelas_eksprimen | ,133 | 30 | ,183 | ,934 | 30 | ,263 |

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| | | | | | | |
|---|---|---|---|---|---|---|
| posttest_kelas_eksprimen | ,442 | 30 | ,000 | ,595 | 30 | ,300 |
| pretest_kelas_kontrol | ,138 | 30 | ,152 | ,929 | 30 | ,246 |
| posttest_kelas_kontrol | ,234 | 30 | ,000 | ,911 | 30 | ,315 |

a. Lilliefors Significance Correction

*(Source: SPSS 25.0)*

Based on the table above, it can be seen that:
a. Pretest data on control and experimental classes were not normally distributed (Sig.< 0.05).
b. Posttest data in both classes had a significance value of more than 0.05, so it was normally distributed.
Thus, most *of the posttest* data that will be used in the test is normally distributed, so parametric statistical tests such as t-tests can still be used to analyze differences between groups.

**b. Homogeneity Test**

The homogeneity test was carried out to find out whether the variance in communication ability between the experimental class and the control class was the same (homogeneous).The test was performed using *Levene's Test for Equality of Variances* displayed on the SPSS output. Based on the test results, the following significance values were obtained:

**Table 5. Homogeneity Test**

| Test of Homogeneity of Variances | | | | | |
|---|---|---|---|---|---|
| | | Living Statistics | df1 | df2 | Sig. |
| nilai_kemampuan_pemecahan_Problem | Based on Mean | 11,112 | 1 | 58 | ,301 |
| | Based on Median | 11,024 | 1 | 58 | ,301 |
| | Based on Median and with adjusted df | 11,024 | 1 | 60,414 | ,202 |
| | Based on trimmed mean | 11,212 | 1 | 58 | ,301 |

*(Source: SPSS 25.0)*

Since the overall significance value > 0.05, it can be concluded that the problem-solving ability data has a homogeneous variance between the experimental class and the control class. Thus, the data meets the homogeneity assumption and further statistical testing can be performed using a t-test on the *assumed equal variances line*.

**c. T Test**

**Table 4.18 Tests on Problem-Solving Ability**

| Independent Samples Test | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | |
| | | F | Sig. | t | Df | Sig. (2-tailed) | Mean Difference |
| nilai_kemampuan_komunikasi | Equal variances assumed | 11,115 | ,001 | -25,985 | 68 | ,000 | 12,314 |

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| | | | | | | |
|---|---|---|---|---|---|---|
| | Equal variances not assumed | 11,115 | ,001 | -54,451 25,985 | ,000 | 12,314 |

*(Source: SPSS 25.0)*

Based on the results of the Independent *Samples t-Test*, a significance value (Sig. 2-tailed) of 0.000 was obtained in the *line Equal variances not assumed*, because the results of *the Levene* test showed that the data did not have homogeneous variances (Sig. = 0.001 < 0.05). Thus, the second line is used in decision-making. Significance values of 0.000 < 0.05 indicate that there is a significant difference between the control class and the experimental class in problem-solving ability. The average difference between the two groups was 12,314.

**Discussion**

The results of the study show that *the Problem Based Learning* (PBL) learning model has a significant effect on improving students' problem-solving skills.This can be seen from the increase in the average *posttest* score in the experimental class compared to the control class. The average *posttest score* of students in the experimental class reached 95.00, while in the control class it was only 63.33. This improvement reflects the effectiveness of the PBL model in helping students understand the material of the human respiratory system and develop critical thinking skills in problem-solving.

The PBL model encourages students to be more active in learning through syntax stages such as identifying real problems, group discussions, information exploration, developing solutions, and evaluating results. By engaging students directly in real-world problem-solving, students are not only required to memorize concepts, but also to understand, analyze, and apply their knowledge in depth. This is in accordance with the characteristics of 21st century learning which emphasizes the development of high-level thinking skills.

In this study, a statistical test using the Independent *Sample t-Test* produced a significance value of 0.000 < 0.05, which shows that there is a significant difference between the problem-solving ability of students taught using PBL compared to conventional learning. In addition, the normality and homogeneity test showed that the data were worth analyzing parametrically, strengthening the validity of the conclusions. Furthermore, a fairly drastic increase in the experimental class was also shown by the decrease in the standard deviation from *pretest* to *posttest*, from 16.40 to 5.48, which indicates that students' abilities became more even after the application of the PBL model. In contrast, in the control class, the standard deviation *of the posttest* remained high (17.61), indicating irregularities in learning outcomes that were most likely caused by the lack of active involvement of students in the learning process.

These results are in line with previous research by and which concluded that the PBL model is effective in improving students' problem-solving skills in various Biology subjects. This research strengthens the empirical evidence that the application of PBL is very suitable for complex subjects such as the human respiratory system, as it requires a thorough understanding and high-level thinking skills in solving real health problems. ( São Paulo & São Paulo , 2023) ( Simatupang & Ionita , 2020)

Thus, it can be concluded that the application of *the Problem Based Learning model* can effectively improve the problem-solving skills of high school students, especially in understanding the concept of the human respiratory system. Teachers are advised to apply this learning model more broadly, not only to specific biology materials, but also to a variety of other learning materials that require conceptual understanding and the application of critical thinking.

## CONCLUSION

Based on the results of the research, it can be concluded that the *Problem Based Learning* (PBL) learning model has a significant influence on improving students' problem-solving abilities in the human respiratory system material at SMA Negeri 1 Bahorok. This is shown by the much higher difference in the mean posttest results in the experimental class compared to the control class. The PBL model has been proven to be able to activate students in the learning process, improve critical thinking skills, and deepen their understanding of biological concepts contextually. The systematic application of PBL syntax from problem orientation to solution evaluation, facilitates students to learn actively and independently, and is able to relate theory to real-world problems. Therefore, this model is highly recommended to be applied in biology learning, especially complex and applicative materials such

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as the human respiratory system.

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ISSN: 2086-6135 E-ISSN: 2541-612x
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