

## Effect of Problem-Based Learning on the Student Problem-Solving Skills

Nurvita Putri Utami<sup>1</sup>, Fitria Wulandari<sup>2\*</sup>

<sup>1</sup>Department of Elementary School Teacher Education, Faculty of Psychology and Education, Universitas Muhammadiyah Sidoarjo, Jawa Timur, Indonesia

<sup>2</sup>Teacher Professional Education, Universitas Muhammadiyah Sidoarjo, Jawa Timur, Indonesia

\*e-mail: [fitriawulandari1@umsida.ac.id](mailto:fitriawulandari1@umsida.ac.id)

Received: June 19, 2025. Accepted: July 16, 2025. Published: April 25, 2025

**Abstract:** Science learning in elementary schools is expected to not only provide conceptual understanding but also foster students' ability to solve real-life problems through active learning. This study was conducted to measure the effect of Problem-Based Learning on the problem-solving ability of fifth-grade students of SDN Krembung 1 in learning science on the human respiratory system. The One Group Pretest-Posttest research design was used to test the instrument's validity and reliability, assess the normality and homogeneity of the pretest and posttest results, and determine the influence using the T Test. The instrument developed by the researcher was based on the problem-solving indicators developed by George Polya: (1) Understanding the problem, (2) Planning Problem Solving, (3) Implementing the problem-solving plan, and (4) Checking the Process and Results of problem solving. Problem-Based Learning is applied through five stages, namely: (1) Orientation to the problem, (2) organising students, (3) guiding the investigation, (4) developing and presenting results, and (5) analysing and evaluating the problem-solving process. The pretest was carried out first, followed by the application of the problem-based learning model, and then the posttest. The average pretest score was 79 (68–89), and the average posttest score was 90 (75–100). The results of the paired sample t-test analysis showed a significance value (2-tailed) of 0.000, which means there is a significant difference between the pretest and posttest results. These findings suggest that integrating Problem-Based Learning into classroom instruction not only enhances students' problem-solving abilities but also aligns well with the goals of competency-based curricula such as the Merdeka Curriculum, which emphasize active learning and critical thinking. Thus, Problem-Based Learning is effective in improving students' problem-solving abilities.

**Keywords:** Human Respiratory System; Problem-Based Learning, Problem-Solving Skills, Social-Science Subject.

### Introduction

Science learning at the elementary school level teaches students basic knowledge through scientific concepts related to nature, with the aim of fostering curiosity, integrated observation skills in social life, and critical and logical thinking skills from an early age [1]. The main objective of science learning is to foster curiosity, observation skills, critical and analytical thinking skills, and caring attitudes towards the surrounding environment. The Independent Curriculum emphasizes the importance of student-centered, contextual, exploration-based and problem-solving learning [2]. Problem-solving skills in students practice, science learning still uses a lot of teacher-centered methods and emphasizes memorization of concepts, which causes learning to be passive [3]. This method results in suboptimal student learning outcomes, with problem-solving skills and learning objectives not being achieved. Low student learning outcomes trigger a domino effect that leads to difficulties in subsequent learning.

One material with high relevance to real life is the human respiratory system. This material teaches students about the respiratory organs, the working mechanisms of the respiratory system, and the importance of maintaining respiratory health. A good understanding of the respiratory system not only forms conceptual knowledge but also raises awareness of risk factors such as air pollution, passive smoking, and poor ventilation [4]. Therefore, in order for

students to gain comprehensive understanding, a learning strategy is needed that is not only cognitive, but also triggers students' emotional and social involvement in health and environmental issues. However, in practice, students' ability to solve problems related to the human respiratory system is still relatively low. Students have not shown the ability to analyze everyday problems related to breathing, such as the impact of air pollution or unhealthy lifestyles, and have not been able to link the material to real, contextual solutions. Students' ability to understand the material during learning is an important part of the teacher's role in the classroom [5]. With the diversity of student understanding, if they have low conceptual understanding, students not only have difficulty in dealing with questions, but can also be hampered in practicing the material in real life [6].

Teachers are the main facilitators with the task of exploring, developing, and optimizing students' potential when entering an ethical society [7]. However, the role of teachers is not only to transfer knowledge to students, but also to foster the development of civilized, high-quality students [8]. Therefore, in the process of organizing education and learning, quality teachers are needed, in addition to mastering the material to be delivered, having the ability to apply various learning methods, and being proficient in classroom management [9].

The Problem-Based Learning (PBL) learning model is one approach that aligns with the spirit of the Independent Curriculum in stimulating meaningful and active learning

### How to Cite:

N. P. Utami and F. Wulandari, "Effect of Problem-Based Learning on the Student Problem-Solving Skills", *J. Pijar.MIPA*, vol. 21, no. 2, pp. 385–390, Apr. 2026. <https://doi.org/10.29303/jpm.v21i2.9405>

[10]. PBL involves students in solving authentic problems relevant to their lives, as well as in developing their ability to think critically, collaborate, and build knowledge independently [11]. Through this approach, students not only become recipients of information but also act as inquirers who explore, evaluate, and construct their understanding of a concept through direct experience [12].

Problem-solving skills cannot be separated from one of the basic skills students must have in the 21st century to face a rapidly changing world. Problem-solving skills become complex mental activities consisting of various cognitive skills and activities, including visualization, association, abstraction, understanding, manipulation, reasoning, analysis, synthesis, generalization, each of which needs to be managed and coordinated [13]. Problem solving is a cognitive process that focuses on achieving a goal whose solution technique is not yet known by students, the cognitive process in problem solving contains four main characteristics; (1) cognitive problem solving, (2) problem solving processing (3) direct problem solving, (4) personal problem solving [14]. Of course, with a good understanding of problem-solving, students can equip themselves to overcome the obstacles they will encounter in the future.

Based on initial observations of the learning process in grade V science at SDN Krembung 1, most students had difficulty with questions or activities that required applying the concept of the human respiratory system to contextual problems. For example, if instructed to mention the causes of children often having shortness of breath in an environment full of vehicle smoke and explain how to overcome it, students will answer by mentioning the name of the organ without explaining the relationship between environmental conditions, the breathing process, how smoke affects the respiratory tract, and its impact on the body. This highlights the lack of deep conceptual understanding and contextual reasoning.

While several studies have explored the use of problem-based learning in secondary or higher education contexts, especially in science or health education, there is still limited empirical evidence of its impact at the Indonesian elementary level, particularly on the development of students' problem-solving skills within specific scientific themes, such as the human respiratory system. The observations indicate that fifth-grade students' problem-solving ability remains low. Researchers recommend implementing learning models that stimulate active student involvement, strengthen understanding through direct experience, and develop critical thinking skills. One of the learning models considered appropriate for supporting the implementation of science learning at SDN Krembung 1 is Problem-Based Learning. The PBL model is a learning approach centred on problem-solving, allowing interaction and cooperation between teachers and students, or between students, in finding core solutions to the problems studied [15], [16]. Sudarman explained that PBL is an approach that uses real problems as a learning context, encouraging students to develop critical thinking and problem-solving skills to understand important concepts from the material being studied [15].

In addition, PBL provides students with an opportunity to experience firsthand the process of solving everyday problems and helps them become more active in understanding the material being discussed [17], [18]. This

model is often associated with student-centered learning, where students are encouraged to actively and collaboratively build knowledge through involvement in actual problems or policies that occur in the real world [19].

The Problem-Based Learning (PBL) model provides students with the opportunity to be directly involved in solving problems relevant to everyday life. With this model, students become more active in understanding and interpreting the subject matter being studied [20]. PBL also encourages students to work in groups to identify and solve concrete problems, thereby developing problem-solving skills through critical thinking [21]. Therefore, this research contributes to the literature by offering empirical support for PBL as an effective approach to strengthening problem-solving skills in Indonesian primary education, while also responding to the demands of the Merdeka Curriculum for transformative and active learning. It is expected that the findings will be able to improve the results of learning science in the form of problem-solving skills in human respiratory system material through the application of the Problem-Based Learning (PBL) model in grade V students of SDN Krembung 1 and inform science teachers and curriculum developers in designing more impactful, student-centered learning experiences.

## Research Method

The research method used is quantitative, with a one-group pretest-posttest design, in which subjects are given treatment after the initial measurement (pretest) and re-measured after treatment (posttest). This design aims to determine the effect of a treatment or intervention within the same group by comparing pretest and posttest results [22]. This design does not use a control group, so to increase the validity of the data, appropriate instrument testing and data processing stages are required. The research procedure was carried out in one class that received a pretest before the treatment, namely the implementation of science learning on the human respiratory system using the Problem-Based Learning model. After the treatment, a post-test was administered to compare pre- and post-treatment values; from this, it was determined whether the model used in the study affected students' problem-solving abilities [23]. The One Group Pretest-Posttest design [23] is shown in the following table:

**Table 1.** One Group Pretest-Posttest Design

Pretest	Treatment	Posttest
O <sub>1</sub>	X	O <sub>2</sub>

Keterangan:

O<sub>1</sub> : Pre-Test

X : Treatment with Problem-Based Learning

O<sub>2</sub> : Post-Test

Although the one-group pretest-posttest design is known to have limitations in internal validity due to the absence of a control group, it was selected given the research setting's contextual constraints. The school permitted intervention only in one class, and random assignment was not feasible due to ethical and administrative considerations. To strengthen the credibility of the findings despite this limitation, the study emphasized rigorous instrument

validation, normality testing, and statistical analysis to ensure robustness of the data.

The subjects of this study were 17 fifth-grade students of SDN Krembung 1. The subjects were selected through purposive sampling because the class is studying the human respiratory system, which aligns with the study's focus. Before treatment, students will take an initial test (pretest) to assess their problem-solving skills related to the respiratory system material. This pretest is designed based on the indicators of problem-solving abilities according to Polya, which include: (1) understanding and identifying problems, (2) planning problem-solving strategies, (3) implementing the plan or strategy, and (4) checking and re-evaluating the process and results of problem-solving [24].

The treatment was conducted over four instructional meetings, each lasting approximately 70 minutes. During these sessions, science lessons were delivered using the Problem-Based Learning (PBL) model. Students were presented with contextual problems related to the respiratory system and guided to find solutions through group collaboration, discussions, simple investigations, and presentation of findings. The teacher acts as a facilitator who guides the implementation of learning so that it takes place in accordance with the PBL stages, namely: (1) orientation to the problem, (2) organizing students in learning, (3) guiding investigations, (4) developing and presenting work results, and (5) analyzing and evaluating the problem-solving process.

After all the learning and syntax implementation, students will be given a final test (posttest) identical to the pretest to measure their improvement in problem-solving abilities. The results of the pretest and posttest are then analyzed to see if there is a significant difference in scores before and after the implementation of the PBL model. This difference in scores reflects the influence of the Problem-Based Learning model on students' problem-solving abilities.

The first stage in implementing this research is to conduct an instrument validity test to ensure that each question item actually measures the intended aspect of ability. After validity is tested, a reliability test is conducted to assess the consistency of the instrument's measurement results.

Prior to data collection, ethical considerations were addressed by obtaining formal permission from the school principal and classroom teacher. Students and their guardians were also informed about the research objectives, procedures, and their rights, and verbal informed consent was obtained from students with school approval, ensuring voluntary participation and the confidentiality of student responses. Before the instrument is used to measure students' problem-solving abilities, a validity and reliability test is conducted to ensure the quality of the questions. The validity test is carried out using the Pearson product-moment correlation technique for each question item on the instrument. The following are the measurement results for the validity of the problem-solving ability instrument.

The results of the analysis show that 6 indicator items have significant correlation coefficients and are above the r table value at the 5% significance level, and 1 item is below the r table value at the 5% significance level (Table 2). Thus, 6 items are declared valid and suitable for collecting research

data. The next step is to measure reliability using Cronbach's Alpha to assess the instrument's internal consistency.

**Table 2.** Validity Test Result

Variabel	Indicator	r-count	Criteria
Analyzing	Item 1	0.822	Valid
Understanding the Problems	Item 2	0.126	Tidak Valid
Designing and Planning a Solution	Item 3	0.867	Valid
	Item 4	0.713	Valid
Solving the Problem	Item 5	0.701	Valid
Re-checking all the steps taken	Item 6	0.852	Valid
	Item 7	0.604	Valid

Noted: r-table 0.455

**Table 3.** Reliability Test Result

Cronbach's Alpha	N of Items
.790	7

The calculation results show a Cronbach's Alpha of 0.79, which exceeds the minimum of 0.60. Based on standard interpretation, this figure falls within the category and can be considered reliable. In the validity and reliability test, it was also concluded that the instrument used in the study had good validity and reliability, and met the requirements as a proper measuring instrument for collecting data on the problem-solving abilities of grade V students of SDN Krembung 1.

After collecting data from the pretest and posttest results, the next step is to conduct a normality test to ensure the data are normally distributed and a homogeneity test to assess whether the data have uniform variance. Data analysis in this study used SPSS 21. If both assumptions are met, the data is analyzed using a paired t-test (Paired Sample T-Test) to test the significance of the difference between the pretest and posttest scores in the same group.

## Results and Discussion

This study involved 17 fifth-grade students (9 female and 8 male) aged 10-11 years. Students completed a pretest before the intervention and a posttest after the intervention to assess the impact of the Problem-Based Learning (PBL) model on their problem-solving abilities. The pretest scores averaged 79, ranging from 68 to 89. After the intervention, the posttest average increased to 90 (range 75-100), indicating an 11-point improvement.

A Shapiro-Wilk normality test confirmed that both pretest ( $p = 0.140$ ) and posttest ( $p = 0.051$ ) scores were normally distributed, allowing the use of parametric testing. The Paired Sample T-Test revealed a statistically significant difference in means ( $t = -6.935$ ,  $df = 16$ ,  $p = 0.000$ ), confirming that the PBL intervention had a significant positive effect on students' problem-solving abilities. Therefore, the data meet the requirements for further parametric statistical analysis. The following are the data from the normality test results (Table 4).

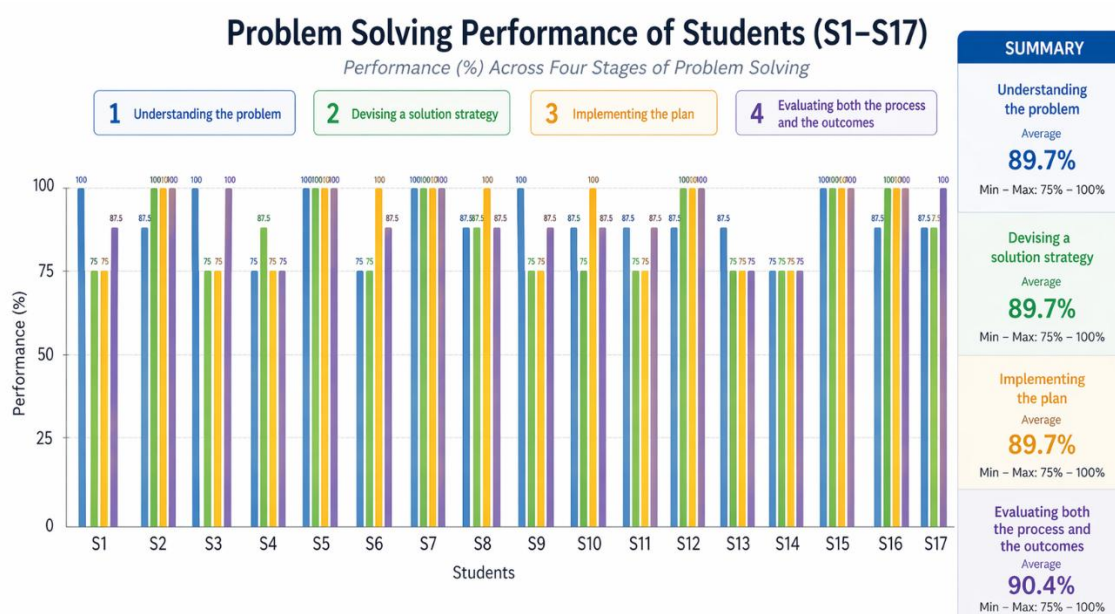


Figure 1. Average score of problem-solving skills

Table 4. Normality Test Result

	Kolmogorov-Smirnov <sup>a</sup>			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Posttet	.187	17	.116	.919	17	.140
Pretest	.191	17	.102	.893	17	.051

a. Lilliefors Significance Correction

The pretest and posttest data with the sig.<0.05 are normally distributed. This information serves as the basis for testing the hypothesis and evaluating the treatment's effect on students' problem-solving abilities. The increase in scores suggests enhanced critical and systematic thinking, particularly in understanding problems, devising strategies, implementing solutions, and reflecting on the results. These cognitive processes are vital in learning topics like the human respiratory system, which requires not only conceptual understanding but also the ability to contextualize issues such as air pollution and respiratory health in daily life.

After conducting all necessary tests on the research data, the results show a significant difference between the pretest and posttest scores for students' problem-solving abilities following problem-based learning treatment on the human respiratory system in science. This is supported by the Paired Sample T-Test results, which show a significance value of 0.000 < 0.05, indicating that problem-based learning improves students' problem-solving abilities.

These findings align with several previous studies, including one conducted at SD Gugus III Baranti District, Sidrap, which found a positive, significant influence of PBL on improving the problem-solving abilities of fifth-grade students in human and environmental materials. The results of the statistical test showed a very small p-value (0.000), indicating the effectiveness of this model in strengthening students' conceptual understanding and problem-solving skills [25]. In addition to improving learning outcomes, PBL also encourages students to be more active, reflective, and collaborative in the learning process, thereby creating a learning environment that supports the development of students' holistic competencies [26].

Compared to traditional models such as Direct Instruction, which often emphasize content delivery over inquiry, PBL encourages students to construct understanding actively. Although Direct Instruction can be effective for foundational knowledge, it may fall short in developing higher-order thinking if not supplemented with interactive elements. Likewise, Inquiry-Based Learning (IBL) shares similarities with PBL but tends to focus more on student-formulated questions, which may be more suitable for older students with greater independence in learning.

Furthermore, it is worth noting that student backgrounds, such as socioeconomic status, school location (urban vs rural), and prior academic achievement, can influence how effectively PBL is received. While this study was conducted in a public school with relatively homogeneous student characteristics, future studies should investigate whether similar outcomes occur in more diverse settings or among students with learning difficulties.

It is important to acknowledge that the one-group pretest-posttest design limits the ability to control for external variables that may influence student improvement, such as maturation, test familiarity, or external academic support. Despite this, the significant score improvement and the structured implementation of the PBL model—including the use of contextual problems, collaborative work, and student reflection—offer compelling evidence of learning gains that align with the characteristics of PBL as described in previous literature.

To further reinforce the contribution of this study, a deeper examination of the learning process's uniqueness was conducted. Observations and field notes revealed that students demonstrated notable engagement, asked more questions about real-life contexts (e.g., air pollution and health), and formulated solutions that linked scientific reasoning to daily experience. These qualitative aspects, while not formally measured, support the quantitative findings and illustrate the transformative potential of PBL even in limited research designs.

Future research is strongly recommended to use quasi-experimental designs with control or comparison

groups, or to combine quantitative and qualitative approaches to more comprehensively explore the process-based impact of PBL.

## Conclusion

Based on the data analysis and discussion presented, it can be concluded that the implementation of the Problem Based Learning (PBL) model has a significant effect on the problem-solving abilities of fifth-grade students, particularly in the science topic of the human respiratory system at SDN Krembung 1. The statistical analysis confirmed a meaningful increase in students' posttest scores compared to their pretest performance, and the significance level ( $p = 0.000$ ) clearly indicates that the intervention contributed positively to learning outcomes. The active involvement of students in exploring contextual problems, linking classroom learning to social or environmental phenomena, and collaborating in finding solutions has strengthened their critical, analytical, and reflective thinking. This aligns with the objectives of the Merdeka Curriculum, which emphasizes student-centered and meaningful learning. The instruments used in this study were proven to be valid and reliable, ensuring that the findings are scientifically credible. Therefore, this study provides a solid foundation to recommend the PBL model as an alternative learning strategy that promotes deeper understanding and active engagement in science learning. In addition to these findings, this study highlights that diverse applications of learning models, when tailored to both student characteristics and specific learning materials, can significantly improve students' learning experiences. The success of PBL in this context suggests its potential to be adapted for other science topics—such as the circulatory system, ecosystems, or weather—and applied in different grade levels with appropriate modifications to the complexity and support given.

## Author's Contribution

N.P Utami: contributed to the research and data collection.  
F. Wulandari: contributed to correcting the method and checking the final manuscript.

## Acknowledgements

The researchers would like to express their deepest gratitude to the University Muhammadiyah Sidoarjo. In addition, the researchers would also like to thank the principal, teachers, and students at SDN Krembung I for their cooperation and assistance, which greatly contributed to the smooth implementation of this research.

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