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THE EFFECTIVENESS OF PBL MODEL IN IMPROVING STUDENTS' CRITICAL THINKING SKILLS IN SCIENCE LEARNING IN SDN DUREN SAWIT 14: A MIXED METHODS RESEARCH

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ABSTRACT

The development of critical thinking skills is an important requirement in 21st-century learning, especially in Natural and Social Sciences (IPAS) learning in elementary schools. However, learning that is still dominated by conventional and teacher-centered methods causes students' critical thinking skills to not develop optimally. This study aims to analyze the effect of the PBL model on improving students' critical thinking skills and describe the process of its implementation in IPAS learning. This study used a mixed methods design that combines quantitative and qualitative approaches. The research subjects consisted of two elementary school classes IV-A (29 students) and IV-B (29 students). Quantitative data were collected through critical thinking skills tests and analyzed using descriptive statistics and independent sample t-tests. The qualitative approach was carried out through observation, interviews, and documentation studies to obtain an in-depth picture of the implementation of the PBL model. The results of the hypothesis test showed that at the pre-test stage there was no significant difference between the experimental class and the control class (t-count = 2.470; Sig. = 0.020), so that students' initial abilities were relatively equal. However, the t-test results on the post-test showed a significant difference between the two classes (t-count = 7.228; Sig. = 0.001), with the average post-test score of the experimental class being higher than the control class. The qualitative findings support the quantitative results by showing that the implementation of PBL improves students' activeness, problem-analyzing abilities, and collaborative skills. Thus, it can be concluded that the Problem-Based Learning model is effective in improving students' critical thinking skills and creating more active and meaningful science learning in elementary schools.
Keywords: critical thinking; PBL; natural and social sciences; collaborative skills

INTRODUCTION

Education is a crucial process for shaping students' character and abilities to face the challenges of the 21st century. The importance of critical thinking skills in education and the urgency of developing them from elementary school onward, in. fact only limited studies specifically exploring how critical thinking skills are systematically integrated into elementary school. At this level, learning not only focuses on factual knowledge but also emphasizes the development of critical thinking skills as a core competency in society (Dwyer *et al*., 2014). Critical thinking enables students to analyze information, evaluate problems, make reasoned decisions, and propose logical solutions, which are essential for responding to complex and dynamic real-life situations (Derman & Bezen, 2026). Therefore, integrating critical thinking skills into classroom instruction is fundamental to preparing students to become active, reflective, and independent learners (Taşkın-Gökçe & Kandır, 2026).

Natural and Social Sciences (IPAS) subjects in elementary schools are a form of integration between science and social studies, emphasizing the relationship between humans and their natural and social environments (Rosiyani *et al*., 2024). Therefore, IPAS learning must be conducted contextually and meaningfully so that students can connect theoretical concepts to real-life situations. Through contextual learning, students are encouraged to observe real phenomena, identify problems, analyze information, and develop solutions based on scientific reasoning and social awareness (Cristiana *et al*., 2021). These learning activities directly support the development of critical thinking skills, as students are trained to interpret data, evaluate various perspectives, draw logical conclusions, and make informed decisions. Consequently, IPAS learning not only strengthens conceptual understanding but also fosters students' ability to think critically and respond effectively to problems encountered in their daily social and environmental contexts (Ariza Rahmadana Hidayati *et al*., 2021).

Based on initial observations in October 2025 at SDN Duren Sawit 14, East Jakarta, researchers found that Duren Sawit 14 is a state elementary school with a large student population and diverse socioeconomic backgrounds. Initial interviews with fourth-grade teachers indicated that the limited implementation of innovative learning approaches was influenced by several factors, including: (1) insufficient training and professional mentoring related to innovative instructional models; (2) limited instructional time available for implementing student-centered learning; (3) inadequate facilities, particularly digital learning media and teaching aids; and (4) the absence of clear and practical guidelines for applying innovative learning models, such as problem-based learning, in science and social science instruction. This is further explained in the following graph: Graph of the Gap Between Teacher Readiness and Student Activity in PBL Learning. The graph shows that teacher readiness to implement the PBL model is 50%, student activity is 30%, and supporting facilities and infrastructure are 80%. Therefore, these findings indicate a significant need to strengthen the implementation of the Problem-Based Learning model by increasing student engagement and providing more structured guidance and support for teachers in order to optimize science and social science learning outcomes at SDN Duren Sawit 14.

One of the learning models that aligns closely with the characteristics of science and social studies is the Problem-Based Learning (PBL) model (Sulistiana, 2022). The PBL model emphasizes student-centered learning, where the learning process begins with the presentation of contextual, real-life problems that are relevant to students' experiences. Through these problems, students are encouraged to actively construct knowledge by engaging in exploratory, collaborative, and reflective activities, such as identifying problems, formulating hypotheses, collecting and analyzing data, and proposing solutions (Janah & Dimas, 2021; Tri Pudji Astuti, 2019). In this model, the teacher's role shifts from being a primary source of information to a facilitator who guides, motivates, and supports students' thinking processes, inquiry skills, and group interactions (Erni Mariana *et al*., 2022).

Nevertheless, the successful implementation of PBL is highly dependent

on several supporting factors, especially from teacher's pedagogical competence. Teachers need to have a strong understanding of PBL syntax, effective classroom management skills, and the ability to design meaningful problem scenarios. In addition, school conditions such as time allocation, class size, and institutional support play a crucial role in determining the effectiveness of PBL in achieving learning objectives.

PBL is one learning model that can help students practice the skills needed in today's era of globalization (Ribka Rantung *et al*., 2025). The PBL Learning model is recognized as one that can foster students' retrieval of material and encourage them to participate more actively in the learning process (Ibefati Zai *et al*., 2025; Ikstanti & Yulianti, 2023). John Dewey's theory as it viewed schools as a reflection of society at large, and the classroom as a laboratory for investigating and solving real-world problems (Irhas, 2025). John Dewey's teaching theory encouraged educators to engage students in problem-oriented projects and help them explore social issues and their intellectual significance (Ach. Subairi, 2024).

Meanwhile, Duch explained that Problem-Based Learning (PBL) is a learning model that invites students to "learn how to learn," students learn in pairs to find solutions to real-world problems (Duch, 1997). These problems are used to engage students in curiosity about the intended learning. Arends argues that PBL is a learning model in which students are confronted with authentic and real-life problems, enabling them to construct their own knowledge, develop higher-order skills and inquiry, foster student independence, and enhance self-confidence. (Mandasari, 2021). PBL model focuses on problems, making the learning process student-centered. Students are expected to be energetically engaged during the classroom learning process, while educators present problems that students need to understand (Khoiriyah & Husamah, 2018a). In terms of learning organization, students are trained to identify or identify problems and offer solutions. Based on the opinions of several experts regarding the definition of Problem-Based Learning, it can be concluded that PBL learning model places students at the center of learning activities through solving real-life problems (Khoiriyah & Husamah, 2018b). Problem-Based Learning encourages students to think critically, collaborate, and construct knowledge independently through a process of inquiry.

The application of the PBL model requires careful consideration (Meng *et al*., 2023). It is divided into several stages. The syntax of the PBL model in learning is implemented through several steps as follows. (1) orientation of the problems where teacher explains learning objectives, inform students of the necessary requirements, and encourage students to become involved in the problem-solving process, (2) organize the learning situations where teacher helps students understand problems and design learning activities appropriate to the existing situation and conditions, (3) guide to the investigations; teacher assists students in seeking information, conducting experiments, and developing an understanding of how to solve the given problem, (4) develop and presenting the students' work; teacher provides instructions and guidance to students in planning and preparing projects in the form of reports, and support collaboration among group members, and (5) analyze and evaluate the problem-

solving process: at the end of the learning activity, the teacher assists students in thinking about the outcomes of their investigations and evaluating how much they learned during the process. (Nafiah & Suyanto, 2014).

Current research trends indicate that PBL implementation at the elementary school level contributes positively to students' analytical abilities, reasoning skills, and engagement in learning processes (Khoiriyah & Husamah, 2018a; Mandasari, 2021; Nafiah & Suyanto, 2014; Richardson, 2009). Several studies report that students exposed to PBL demonstrate higher levels of critical thinking, motivation, and learning outcome compared to those taught using conventional, teacher-centered approaches (Afandi *et al*., 2024; Putra & Yuni Saputri, 2025; Wiyono *et al*., 2025). However, recent literature also reveals that the effectiveness of PBL is strongly affected by teacher readiness, instructional design, and classroom conditions (Amirulloh *et al*., 2025; Meiliasari *et al*., 2025). Many studies focus on measuring learning outcomes quantitatively, while fewer studies integrate mixed methods approaches that simultaneously examine learning outcomes and the quality of PBL implementation in real classroom settings. In addition, limited research has specifically examined the application of PBL in Natural and Social Sciences (IPAS) at the elementary school level, particularly in public schools with diverse student backgrounds. Therefore, this study positions itself at the intersection of PBL implementation, critical thinking skill development, and mixed methods research, contributing empirical evidence on both the effectiveness and the practical implementation of PBL in elementary Natural and Social Sciences (IPAS).

To sum up, the PBL model is very suitable for science learning because it encourages students to research, observe, and understand phenomena around them, such as the environment, energy, social, and cultural phenomena. The implementation of PBL at SDN Duren Sawit 14 is expected to increase students' critical thinking skills, collaboration, and analytical skills in dealing with real-world problems. Based on this background, the researcher formulated the following research questions:

1. Is there any significant different effect of PBL learning model implementation in increasing students' science critical thinking skills of fourth graders at SDN Duren Sawit 14?
2. How is the PBL learning model implemented in science learning of fourth graders at SDN Duren Sawit 14?

METHODS

This research uses a mixed method approach that combines qualitative and qualitative approaches (Sugiyono, 2011). Qualitative research is a type of educational research in which the researcher relies on the views of participants or informants where the researcher asks extensive questions, asks general questions, collects data consisting largely of the words of participants, describes and analyzes the text into themes, and make conclusion (Creswell, 2014). Meanwhile, quantitative research is a quasi-experimental quantitative research method that aims to test the effect of a treatment on a particular variable by using an experimental group and a control group to observe changes in behavior or certain abilities based on the

treatment that has been administered (Creswell & Guetterman, 2015). Based on this statement, it can be seen that the mix method research relies on answers and data results from informants (Creswell & Clark, 2018). Researchers can use various methods to obtain information from informants and then analyze the data.

The population of this study were fourth grade students of SDN Duren Sawit 14 consist of 58 students which divided into classes IV-A (29 students) and IV-B (29 students). All population were chosen as samples of study using saturation sampling techniques (Budiyono, 2017). In the quasi-experimental quantitative research design with Nonequivalent Control Group Design, the sample size is one experimental class and one control class with the assumption that 58 students from both classes are sufficient to be selected as samples.

The location of this research was SDN Duren Sawit 14, located on Jl. Madrasah II, Duren Sawit Village, Duren Sawit District, East Jakarta. This research was conducted from October 2025 to November 2025. The subjects in this study were grouped into two groups: primary subjects and secondary subjects. Primary subjects were obtained from informants who directly related to the research focus through in-depth observations and interviews, including the principal of SDN Duren Sawit 14, the fourth-grade teachers of SDN Duren Sawit 14, and the students of SDN Duren Sawit 14. Meanwhile, secondary data served as supporting data to strengthen and complement the data from the primary data, which included the fourth-grade teacher module and the school's environmental conditions. Data from both data sets were used in an integrated manner to obtain a comprehensive and accurate picture in line with the research objectives.

In the quantitative data analysis, the researchers used two types of statistical formula; they are descriptive statistics and inferential statistics (test of data normality, test of data homogeneity, and test of hypothesis using paired-sample t-test). The quasi-experimental design used for treatment used Non-Equivalent Control Group Design, as stated in the below table:

Table 1. The Non-Equivalent Control Group Design Scheme

Class	Pretest	Treatment	Posttest
Experiment	O_1	X	O_2
Control	O_3	-	O_4

Note:

O1: Pretest results for the experimental group before treatment.
O2: Pretest results for the experimental group after treatment.
O3 : Posttest results for the experimental group before treatment.
O4: Posttest results for the experimental group after treatment.
X: Treatment given to the experimental group (PBL)

Meanwhile, in qualitative data analysis non-tests such as interviews, observations, and document studies. In-depth and semi-structured interviews were conducted to obtain information regarding the learning process of the Problem-Based Learning (PBL) model to science learning in fourth grade. Five interviewees of qualitative design were involved: one principal, one fourth-grade teacher, and three students selected based on varying academic achievement (high, medium, and low) to examine the relationship between learning outcomes and student attitudes. Structured observations were conducted by directly observing the science learning process occurred, particularly teacher and student activities in implementing the PBL

model. Furthermore, the study documents are used to review field notes, archives, learning documents, and photo documentation related to PBL implementation, so that they can strengthen and complement the data obtained from interviews and observations (Khoa *et al*., 2023). All qualitative data were analyzed using triangulation across data sources and manually coded through systematic categorization to identify emerging themes and patterns.

RESULT AND DISCUSSION

The Effect of PBL Learning Model in Increasing Students' Science Critical Thinking Skills

After conducting research at SDN Duren Sawit 14, East Jakarta, the researcher obtained a significant amount of data related to this study. Data collection for this study took place on October 11, 2025. The researcher obtained permission from the principal and the teacher of class and took IV-A as the control class and IV-B as the experimental class. Below were the result of pretest and posttest from both classes:

Table 2. Results of Descriptive Statistics

No.	Types of Tests	N	Mean	Mode	Median
1.	Pre-Test Experiment	29	73.45	65	75
2.	Pre-Test Control	29	69.83	70	70
3.	Post-Test Experiment	29	82.76	85	85
4.	Post-Test Control	29	74.66	75	75

Based on the pretest and posttest data from both classes, the initial abilities of the experimental and control classes were relatively comparable, with pre-test averages of 73.45 and 69.83, respectively. After treatment, the experimental class showed a higher increase in learning outcomes with a post-test average of 82.76 compared to the control class of 74.66. This indicates a greater increase in learning outcomes compared to the control class confirming the effectiveness of the treatment applied to the experimental class.

Table 3. Results of Normality Test

No.	Types of Tests	N	Test Statistic	Sig.2 tailed	Results
1.	Pre-test Experiment	29	0.147	0.111	Normal
2.	Pre-test Control	29	0.154	0.154	Normal
3.	Post-test Experiment	29	0.178	0.129	Normal
4.	Post-test Control	29	0.133	0.200	Normal

Results of the normality test on pre-test and post-test data from both groups showed that all data were normally distributed. This was evident from the Sig. 2-tailed of each variable being greater than 0.05, which are the experimental pre-test at 0.147, control pre-test at 0.154, experimental post-test at 0.129, and control post-test at 0.200. Therefore, these data met an assumption of normality and could be used in parametric statistical analysis.

Table 4. Results of Homogeneity Test

No.	Types of Tests	N	Levene's Test Statistic	Sig.
1.	Pre-test Experiment and Control	29	1.092	0.305
2.	Post-test Experiment and Control	29	1.778	0.192

The results of the homogeneity of variance test indicated that the pre-test and post-test data between both groups were homogeneous. This was evidenced by the significance value in the pre-test of 0.305

and in the post-test of 0.192, both of which were greater than 0.05. It indicated that the variance between groups did not differ significantly, thus fulfilling the requirement of homogeneity of variance as a prerequisite for further analysis.

Hypothesis Testing

Table 7. Result of Hypothesis Testing

No.	Types of Tests	N	T-Counts	T-Tables	Sig.2 tailed
1.	Pre-test Experiment and Control	29	2.470	2.051	0.020
2.	Post-test Experiment and Control	29	7.228	2.051	0.001

The t-test applied to the pre-test data yielded a t-statistic smaller than the critical value (t-count = 2.470 > t-table = 2.042) with a p-value of 0.020, which is greater than 0.05. Consequently, H0 was not rejected and H1 was not supported, indicating there was no significant difference in the mean scores from the pre-test between the group that received the treatment and the group that did not; the initial abilities of the two groups were comparably equal prior to the intervention.

In contrast, the post-test analysis produced a t-statistic exceeding the critical value (t-count= 7.228 > t-table = 2.042) with a p-value of 0.001, which is less than 0.05. Thus, H0 was rejected and H1 was accepted, indicating a significant difference between the mean score of post-test scores of the experimental and control groups. This suggests that the instructional treatment administered to the experimental group more effectively enhanced students' learning outcomes than the control condition.

Based on the hypothesis test, it can be concluded that the students' abilities in the experimental class and the control class were the same before the treatment was given. Before the experiment, a pre-test t-test showed no significant difference effect between the two groups. But after doing the experiment, the post-test t-test showed a significant difference between the experimental group and the control group. After implementing learning processes, an experimental class achieved better learning outcomes compared to a control class; thus, one can conclude that instructional effectiveness in an experimental classroom is greater than that of a control classroom.

The Implementation of PBL Learning Model to Increase Students' Science Critical Thinking Skills

The researcher also collected research data in narrative ways such as school identity, vision, and mission, and conducted observations in classroom on October 22nd, 2025, the researcher observed class during science lessons. The classroom observations included observation of learning process and the teacher's teaching methods. After conducting classroom observations, the researcher then conducted data collection through in-depth interviews with the fourth-grade teacher and three of the 29 fourth-grade students. The purpose of selecting teacher and students as interviewees gain insight into their perspectives on the implementation of PBL model in science learning.

The implementation of the PBL model is carried out in a several steps, including orienting students to the problem, organizing them for learning, creating and looking at their own learning results, and checking and thinking about how they solved a problem. Every lesson is designed to encourage students to actively participate in their education, develop their critical

thinking skills, and assist them in solving problems in a methodical manner.



Picture 1. Teacher oriented the students with the learning problems

In the problem-orientation phase, the teacher introduces contextual problems related to science and natural science topics that are closely connected to students' daily experiences. Through visual stimuli, guiding questions, and real-life examples, students are encouraged to observe the situations presented carefully and understand the core issues involved. At this stage, students practice interpreting initial information, identifying key facts, and formulating relevant questions. These activities play a crucial role in developing critical thinking skills, particularly in terms of problem comprehension, information identification, and question formulation, which serve as the foundation for deeper analytical thinking.

In the organizing students for learning phase, the teacher structures the learning process by dividing students into heterogeneous groups and clearly explaining the tasks. Students collaboratively analyze the given problems, categorize relevant information, and design systematic strategies to address the issues. This phase strengthens students' analytical abilities, as they learn to break down complex problems into manageable components and plan appropriate solutions through discussion and cooperation.

During the guiding inquiry phase, students actively engage in exploring information from various sources, such as textbooks, digital media, and direct observations. They collect and analyze data, compare findings, and use evidence to formulate hypotheses and draw preliminary conclusions. This inquiry process fosters critical thinking skills by training students to make logical inferences, evaluate the credibility of information, and connect empirical data with scientific concepts and principles being studied.



Picture 2. Students presented their group works in front of the class

In the developing and presenting work phase, students compile their findings into structured reports and present their problem-solving results to the class. Through presentations and group discussions, students explain their solutions clearly and defend their arguments using data and evidence obtained during the inquiry process. This phase enhances critical thinking skills related to explanation, logical reasoning, and effective communication, while also building students' confidence and collaborative skills.

Finally, in the assessment and evaluation phase of the problem-solving skills, students and the teacher collaboratively reflect on both the learning process and the outcomes achieved. Students evaluate the accuracy and effectiveness of their solutions, identify

strengths and weaknesses in the strategies used, and consider alternative approaches that could be applied. This reflective activity strengthens higher-level critical thinking skills, including evaluation, reflection, and rational decision-making, enabling students to become more thoughtful and independent learners.

To gain a clearer picture of the implementation of PBL learning model in science learning, researchers conducted interviews with fourth-grade teachers regarding the types of learning media used during the learning activities. These interviews aimed to determine how teachers utilize various media to support problem-based learning and their role in helping students understand problems.:

> *"In teaching using the Problem-Based Learning model, teacher used various types of learning media, such as visual media in the form of images, posters, and PowerPoint slides to help students understand problems more clearly. Teacher also utilized audiovisual media in the form of learning videos and environmental displays so that students can see real-life examples of the material being studied. In addition, teacher used Student Worksheets (LKPD) as a guide for students in solving problems step by step through group discussions. Teacher also utilized the environment around the school as a learning resource, for example by inviting students to conduct direct observations. To support learning, teacher used technology such as laptops, projectors, and the internet as additional sources of information." (Interview; Teacher AZ, October 22, 2025)*

The quality of IPAS teaching and learning can be markedly enhanced through the adoption of the PBL model, complemented by a diverse range of learning resources. Students' understanding of real-world issues is reinforced, and their engagement in the learning process is augmented when visual, audiovisual, environmental, and technical media are integrated. Beyond aiding the organization of students' critical thinking, the present of student worksheets (LKPD), and natural resources fosters active participation and collaboration. Consequently, the effectiveness of PBL in improving students' critical thinking skills and promoting meaningful learning experiences can be strengthened by the deliberate selection and application of varied learning resources.

To identify the difficulties encountered by students during the implementation of PBL paradigm within IPAS education, researchers conducted a study involving a small cohort of fourth-grade students. The objective of this interview-based inquiry is to identify students' learning challenges and the obstacles they face when engaging in problem-based learning activities.

> *"I think learning through discussion and finding solutions together is interesting, but sometimes the time feels limited because we have to discuss, research, and present our results. Furthermore, our class doesn't have all the teaching aids and media available, so we have to take turns using them. During group discussions, the classroom atmosphere can sometimes become noisy, so we need guidance from the teacher to maintain order."*

(Interview; Student, October 22, 2025)

Based on the research results, the implementation of the Problem-Based Learning (PBL) model in science learning in fourth-grade students at SDN Duren Sawit 14. The fourth-grade teacher implemented problem-based learning in accordance with the stages of Problem-Based Learning syntax, which were implemented through several stages. These steps involve getting students ready to tackle a problem, setting up the learning environment, helping them explore the topic, creating and sharing their work, and reviewing how they solved the problem. When using the PBL, students take part in every part of learning, starting with coming up with questions and gathering information, all the way to sharing what they have learned. This implementation demonstrates that the PBL model is suitable of engaging students and encouraging critical thinking and independence in solving science problems. The teacher acts as a facilitator or guiding students to think critically and actively engage in discussions, collaborate on hypotheses, and seek information from various learning sources to find answers to the problems they face.

Discussion

This study showed that the implementation of the PBL model significantly improved the critical thinking skills of fourth-grade students in science lessons at SDN Duren Sawit 14. These findings address the first research question, which addressed the differences in the effect of PBL implementation on students' critical thinking skills. Based on the hypothesis analysis, there was no significant difference between the main abilities of students in the experimental and control classes, as shown in the pre-test results, indicating that the initial conditions of both groups were relatively equal before the treatment was implemented (Duch, 1997; McDaniel & Schlager, 1990; Nafiah & Suyanto, 2014).

However, after the implementation of the PBL model, quantitative analysis of the post-test revealed a significant difference between the experimental and control classes. The average score of the experimental class increased significantly compared to the control class, with a significance level of less than 0.05. This finding indicates that Problem-based learning helps students think more critically than traditional teaching methods. As reported earlier by (Derman & Bezen, 2026), PBL encourages students to actively engage in problem-solving through analysis, interpretation of information, and evidence-based decision-making. Thus, the results of this study strengthen empirical evidence that PBL is effective in creating student-centered learning and stimulating higher-order thinking processes.

This improvement in critical thinking skills can be explained by the main characteristic of PBL, which places contextual issues as the starting steps for learning (Yuniarti, 2016). Students not only receive information from teachers but also actively construct knowledge through investigation and discussion (Aripin, 2015). This is in accordance with constructivism theory, which emphasizes that knowledge is formed through meaningful learning experiences (Kristanto, 2021) . Therefore, PBL has the potential to start learning environment that challenges students to think beyond learning and reflectively

when facing real-life problems (Gatot Pramono, 2023).

In line with above findings, the qualitative analysis also indicates that the use of diverse learning media, including visual and audiovisual media, student worksheets (LKPD), the surrounding environment, and technology, significantly supports the effectiveness of PBL implementation (Pechenkina & Aeschliman, 2017). These media help students understand problems more concretely and contextually, allowing for optimal critical thinking development (Taşkın-Gökçe & Kandır, 2026). However, this study also identified several obstacles, including limited learning time, inadequate facilities, and classroom management during group discussions. These obstacles demonstrate that the success of PBL depends not solely on the learning model but also on teacher preparedness and school system support.

Overall, the results of this study indicate that the Problem-Based Learning model is a relevant and effective learning approach for developing elementary school students' critical thinking skills, particularly in science and science learning. PBL demands that teachers act more as learning facilitators than as information transmitters, and it also requires schools to be prepared to provide adequate facilities and time management (Ningsih & Rizki, 2024). With consistent implementation and optimal support, PBL has the potential to improve the quality of science and science learning while equipping students with the critical thinking skills necessary to face the challenges of the 21st century (Dwyer *et al*., 2014).

CONCLUSION

This study concludes that the implementation of the PBL gives students a chance to take part in thinking that requires them to look closely at problems, understand information, and make smart decisions based on what they find. The results of the hypothesis test showed the experimental class showed a higher increase in critical thinking skills than the control class. The qualitative findings support the quantitative findings by showing that PBL encourages student activeness, problem-analyzing skills, collaboration, and independent learning.

However, this study has limitations related to the duration of learning and the availability of supporting facilities in the classroom. Therefore, future research has the potential to develop the application of PBL over a longer period and in more diverse school contexts. The results of this study imply that the PBL model can be an an effective science learning strategy to develop the critical thinking skills of elementary school students. In addition, the integration of diverse learning media has been shown to support student engagement and strengthen critical thinking processes. Institutionally, schools need to provide support through teacher professional development and adequate learning resources to ensure optimal PBL implementation.

Based on this research findings, it is recommended that elementary school teachers implement the PBL model continuously in science learning instruction to enhance students' critical thinking skills. Schools are expected to provide more flexible learning times and equip themselves with learning media that support problem-based learning. Future

researchers are advocated to examine the implementation of PBL with combining diverse research designs, also involve students from other grade levels or subjects, and integrating more comprehensive 21st-century skills.

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