

Integrating Problem-Based Learning and a Deep Learning Approach to Foster Scientific Literacy in Elementary School Students

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Abstract

This study aims to foster students' scientific literacy through the integration of the Problem-Based Learning (PBL) model and a deep learning approach in education, specifically targeting upper elementary students (Phase C). Scientific literacy in elementary school is essential to support students in identifying scientific problems, interpreting data, and understanding concepts. However, previous studies frequently separate these interventions or center purely on cognitive scores, leaving a gap in combining PBL with deep learning approaches to explicitly support scientific literacy in upper grades. This Classroom Action Research (CAR) followed the Kemmis and McTaggart framework over two cycles in class VB at SDN 3 Surutanga, Palopo City, involving 27 students. Data were compiled through observation, tests, and documentation. The findings showed that while instructional implementation was high in Cycle I (94.73%), student mastery only hit 51.85% (mean: 70.77), which did not fulfill the success criteria. After reflections were implemented in Cycle II, student learning mastery significantly increased to 77.77% (mean: 80.18). Progress was documented across all four indicators of scientific literacy: understanding concepts, interpreting information, identifying problems, and applying knowledge, with the highest growth in identifying problems and applying knowledge. The integration proved successful in shifting students from surface-level memorization toward active, student-centered scientific engagement.

Keywords: *Deep learning approach; elementary school students; problem-based learning; scientific literacy*

Introduction

Scientific literacy is one of the fundamental competencies students need to keep pace with advances in science and technology in the modern era. This competency encompasses not only the ability to understand concepts, but also to interpret information, solve problems, think critically, and apply knowledge in daily life (Habibah et al., 2024; Suparya et al., 2022). According to the results of the 2022 PISA assessment, the performance of Indonesian students in science remains below the average of OECD member countries, indicating that scientific literacy at the primary level is a major challenge that requires immediate attention.

The findings from preliminary observations and interviews conducted on 27–28 October 2025 in Class VB at State Elementary School 3 Surutanga, Palopo City, confirm this condition. Students appeared passive during lessons, struggled to understand scientific terms, and found it difficult to connect learning material to natural phenomena in their surroundings; additionally, only 33.33% of students met the minimum mastery

criteria in the initial test. This situation calls for an update in learning strategies that align with the developmental stage of students in Phase C under the Independent Curriculum, where learners are expected to begin developing higher-order thinking skills rather than merely memorizing information.

One approach that can be implemented is Problem-Based Learning (PBL), which uses real-world problems as a trigger for learning and trains students to carry out collaborative investigations (Siswanti & Indrajit, 2023; Aryanti et al., 2023). However, applying PBL alone may not be sufficient if students only process information at a superficial level. Therefore, this approach needs to be strengthened through a deep learning framework, which aims to shift learning from rote memorization to meaningful understanding and enable students to connect various scientific concepts (Khotimah & Abdan, 2025; Santiani, 2025).

A review of existing literature shows that research integrating both approaches simultaneously to measure the development of scientific literacy remains very limited. Most studies examine only one variable or measure general learning outcomes without detailing specific indicators of scientific literacy. This study aims to fill that gap by implementing an integrated model of PBL and deep learning, and by measuring its specific impact on the scientific literacy skills of primary school students.

Method

This study employs a Classroom Action Research (CAR) design using the Kemmis and McTaggart model, which consists of four recurring stages: planning, implementation of actions, observation, and reflection (Hopkins, 2020). This design was selected because it allows the researcher, who also acts as the teacher, to make gradual improvements based on the actual conditions in the classroom.

The research was conducted at State Elementary School 3 Surutanga, Palopo City, during the second semester of the 2025/2026 academic year. The subjects of the study were 27 students in Class VB. Data were collected using observation sheets for learning implementation and student activities, scientific literacy tests administered at the end of each cycle, and documentation of learning activities. The indicators of scientific literacy measured included: conceptual understanding, interpretation of information, problem identification, and application of knowledge.

Data analysis was carried out quantitatively using percentage formulas to assess the implementation of instruction and student learning mastery, as well as through qualitative descriptive analysis to describe the processes and results achieved. The study is considered successful if at least 75% of students meet the mastery criteria and the implementation of learning falls within the good or very good category.

Results

The integrated implementation of the Problem-Based Learning model and the deep learning approach was carried out over two cycles of learning activities, with each cycle

consisting of three sessions. Overall, the learning process proceeded well and showed consistent improvement from Cycle I to Cycle II, both in terms of the implementation of activities, student participation, and the attainment of learning outcomes and scientific literacy.

The implementation of learning in Cycle I reached an average of 94.73%, falling into the very good category. Although this figure is already relatively high, several parts of the activities had not been carried out optimally in each session, so improvements were necessary. Following refinements made during the planning and implementation stages in Cycle II, the level of implementation increased to 100% and was maintained consistently across all sessions. In line with this, student participation also improved, rising from an average of 89.47% in Cycle I to 100% in Cycle II. Students became more confident in asking questions, expressing opinions, engaging in discussions, and working collaboratively in groups to solve the problems presented.

Even though the learning process was already proceeding very well in Cycle I, test results showed that student learning mastery only reached 51.85%, with an average score of 70.77 — which did not yet meet the established success criteria. This indicates that a high level of activity implementation does not directly guarantee deep understanding among students. After improvements were made to the learning strategy, clearer guidance was provided, and roles within groups were structured more systematically in Cycle II, learning outcomes improved significantly: 77.77% of students achieved mastery, with an average score of 80.18.

Improvements were also observed across every measured aspect of scientific literacy. The details of this development are as follows:

Table 1. Increase in Average Score per Scientific Literacy Indicator

No	Scientific Literacy Indicator	Cycle I	Cycle II	Change in Category
1	Understanding scientific concepts	68.22	78.44	Moderate → High
2	Interpreting scientific information	65.40	76.12	Moderate → High
3	Identifying problems scientifically	62.11	82.55	Moderate → Very High

Based on the data presented in the table above, all four indicators of scientific literacy improved from Cycle I to Cycle II. The indicators of understanding concepts and interpreting information rose from the moderate to the high category. Meanwhile, the most significant improvement occurred in the indicators of identifying problems and applying knowledge in daily life, both of which increased from moderate to very high. This shows that the integration of these two approaches is most effective in training students' ability to recognize scientific problems and connect learned concepts to real situations in

their surroundings. Overall, these results confirm a shift in students' learning approach from mere memorization to deeper and more meaningful understanding.

Discussion

The findings of this study prove that integrating PBL with the deep learning approach yields a significant positive impact on the development of students' scientific literacy. PBL serves to create an active and contextual learning environment, while the deep learning approach ensures that students do not merely complete tasks, but truly understand and connect the concepts they learn to real-life situations.

The improvements observed across every indicator of scientific literacy show that this approach meets the learning needs of students in Phase C. The indicators of problem identification and knowledge application recorded the highest increase, as these two abilities form the core focus of problem-based learning — which is then reinforced to ensure understanding becomes deep and long-lasting.

These findings align with constructivist learning theory, which posits that knowledge is constructed by learners themselves through experience and interaction. The results also support previous studies indicating that PBL enhances student engagement (Annisa & Rahman, 2024; Widodo et al., 2025), while the deep learning approach strengthens long-term understanding (Mariani et al., 2025; Mutmainnah et al., 2025).

The strength of this research lies in its detailed measurement of each indicator, making it possible to identify which aspects show the greatest progress. This provides a clearer picture compared to earlier studies that only assessed overall learning outcomes.

Conclusion

Based on the results of the study and the discussion, it can be concluded that integrating the Problem-Based Learning model with the deep learning approach is effective in improving the scientific literacy of students in Class VB at State Elementary School 3 Surutanga, Palopo City. This improvement is reflected in the quality of the learning process, student participation, and learning outcomes that met the established success criteria by the second cycle.

In detail, all four indicators of scientific literacy showed improvement, with the highest gains observed in the ability to identify problems and apply knowledge in daily life.

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