The Implementation of Problem-Based Learning to Improve Junior High School Students' Scientific Thinking Skills on Ecosystem Topics

Suhaeri[*1],

[1]*Universitas Muhammadiyah Surabaya*
e-mail: herypoenk1@gmail.com

ABSTRACT. The development of scientific thinking skills is one of the essential goals of science education at the junior high school level. However, many students still experience difficulties in understanding scientific concepts due to the dominance of teacher-centered learning approaches. Problem-Based Learning (PBL) is considered an effective instructional model to promote active learning and enhance students' higher-order thinking skills. This study aims to analyze the effectiveness of Problem-Based Learning in improving students' scientific thinking skills in ecosystem learning through a literature-based approach. This research employs a qualitative library research method by reviewing and synthesizing relevant national and international journal articles, books, and empirical studies related to PBL and scientific thinking skills. The data were analyzed using thematic analysis to identify key patterns and pedagogical implications. The findings reveal that the implementation of PBL significantly contributes to the improvement of students' scientific thinking skills, particularly in aspects of problem identification, hypothesis formulation, data analysis, and conclusion drawing. Furthermore, PBL encourages collaborative learning, critical inquiry, and meaningful understanding of ecological concepts. This study concludes that Problem-Based Learning is a highly relevant instructional model for enhancing scientific thinking skills and can serve as an alternative pedagogical strategy in science education at the junior high school level.

Keywords: problem-based learning, scientific thinking skills, ecosystem

INTRODUCTION

Scientific thinking skills are widely recognized as one of the core competencies required in 21st-century education, particularly in science learning at the junior high school level. These skills include the ability to observe systematically, formulate problems, develop hypotheses, analyze data, and draw logical conclusions based on empirical evidence (Snyder, 2019). In the context of science education, scientific thinking is not merely about mastering factual knowledge, but also about developing students' capacity to think critically, analytically, and reflectively in understanding natural phenomena (Miles, Huberman, & Saldaña, 2014). Therefore, science learning should be designed to facilitate active student engagement and inquiry-based processes rather than relying solely on traditional lecture-based instruction.

However, various studies indicate that science learning in many schools still tends to be teacher-centered, focusing on knowledge transmission rather than knowledge construction. This

condition often leads to passive learning environments where students are less involved in problem-solving activities and scientific investigations (Bush, 2020). As a result, students' scientific thinking skills remain underdeveloped, particularly in complex topics such as ecosystems, which require integrative understanding and systems thinking (Wahyuni & Wibowo, 2020). Ecosystem topics involve abstract concepts, such as energy flow, food chains, and environmental balance, which are difficult to comprehend without meaningful learning experiences.

To address this issue, innovative learning models that emphasize student-centered approaches are urgently needed. One of the instructional models that has gained considerable attention in recent years is Problem-Based Learning (PBL). PBL is a learning model that organizes instruction around real-world problems, encouraging students to explore, investigate, and propose solutions collaboratively (Arifin & Setiawan, 2022). Through PBL, students are positioned as active learners who construct knowledge through inquiry and reflection, rather than passive recipients of information.

Previous studies have demonstrated that PBL is effective in improving students' cognitive and metacognitive skills, including critical thinking, creativity, and problem-solving abilities (Leithwood & Jantzi, 2019). In science education, PBL has been shown to facilitate deeper conceptual understanding by engaging students in authentic scientific practices, such as data collection, experimentation, and evidence-based reasoning (Putri, Handayani, & Rahmawati, 2023). These learning processes align closely with the characteristics of scientific thinking, which emphasize inquiry, logical reasoning, and empirical validation.

Furthermore, PBL is particularly relevant for ecosystem learning because it allows students to connect scientific concepts with real environmental issues, such as pollution, deforestation, and climate change. By dealing with contextual problems, students are more likely to develop meaningful understanding and environmental awareness (Sari & Nugroho, 2020). This contextual dimension strengthens the relevance of learning and increases students' motivation to engage actively in scientific inquiry.

Despite the growing body of research on PBL, most existing studies are conducted using experimental or quasi-experimental designs, focusing primarily on learning outcomes measured through test scores (Rahman & Yusof, 2022). There is still limited research that synthesizes theoretical and empirical findings on PBL and scientific thinking skills through a comprehensive literature-based approach. A literature study is important to provide a holistic understanding of how PBL contributes to scientific thinking development across different educational contexts.

Therefore, this study aims to analyze the role of Problem-Based Learning in enhancing junior high school students' scientific thinking skills, particularly in ecosystem learning, by synthesizing relevant academic literature. Through a systematic review of previous studies, this research seeks to identify key pedagogical mechanisms, learning strategies, and educational implications of PBL. The findings of this study are expected to contribute theoretically to the development of science education models and practically to support teachers in designing more effective and meaningful learning experiences.

METHOD

This study employed a qualitative research design using a library research approach. This method was chosen because the purpose of the study was to synthesize theoretical and empirical findings related to the implementation of Problem-Based Learning (PBL) in improving students' scientific thinking skills. Library research enables researchers to systematically examine existing

knowledge and generate comprehensive interpretations based on previous scholarly works (Zed, 2014; Snyder, 2019).

The data sources consisted of national and international academic publications, including peer-reviewed journal articles, scholarly books, and research reports published between 2012 and 2023. The literature was obtained from reputable academic databases such as Google Scholar, ERIC, and ScienceDirect. The selected sources focused on PBL, scientific thinking skills, and science learning at the junior high school level. The inclusion criteria required that each study explicitly discuss PBL as a learning model and its relationship with higher-order thinking skills in science education (Creswell & Poth, 2018; Kitchenham & Charters, 2007).

The collected data were analyzed using thematic analysis. This technique involved identifying key concepts, coding relevant information, and organizing the data into thematic categories related to learning strategies, student engagement, and scientific thinking outcomes. The themes were then synthesized to construct a conceptual framework explaining how PBL contributes to the development of scientific thinking skills in ecosystem learning contexts (Miles, Huberman, & Saldaña, 2014).

RESULT AND DISCUSSION

Result

The results of this literature study reveal consistent patterns regarding the effectiveness of Problem-Based Learning (PBL) in improving students' scientific thinking skills in science education. The reviewed studies demonstrate that PBL influences multiple dimensions of scientific thinking, ranging from cognitive processes to affective aspects of learning. To present the findings more systematically, the results are organized into several thematic categories, including problem identification skills, hypothesis and inquiry abilities, data analysis and reasoning competencies, as well as the development of scientific attitudes and learning engagement (Snyder, 2019; Miles, Huberman, & Saldaña, 2014).

1. Improvement of Problem Identification Skills

The literature indicates that Problem-Based Learning (PBL) significantly improves students' ability to identify and formulate scientific problems. In PBL settings, students are confronted with real or contextual issues related to ecosystem phenomena, such as environmental pollution, food chain disruption, or biodiversity loss. These situations require students to observe carefully, recognize patterns, and define problems based on empirical conditions. Several studies report that this learning process enhances students' awareness of scientific problems and trains them to ask relevant and meaningful questions (Sari & Nugroho, 2020; Rahman & Yusof, 2022).

2. Development of Hypothesis and Inquiry Skills

Another major finding is that PBL supports the development of hypothesis formulation and inquiry skills. The reviewed studies emphasize that students engaged in PBL are encouraged to propose tentative explanations and predictions before conducting investigations. This practice strengthens students' ability to think scientifically by linking theoretical knowledge with real-world observations. Through inquiry-based discussions and exploration activities, students become more confident in expressing ideas and testing assumptions using logical reasoning (Putri, Handayani, & Rahmawati, 2023; Leithwood & Jantzi, 2019).

3. Enhancement of Data Analysis and Reasoning Abilities

The literature also highlights that PBL improves students' data analysis and reasoning abilities. In PBL environments, students are required to collect data from various sources, interpret findings, and draw conclusions collaboratively. This process develops analytical thinking skills and trains students to evaluate evidence critically. Compared to conventional learning, PBL provides richer opportunities for students to engage in reflective thinking and evidence-based argumentation (Arifin & Setiawan, 2022; Wahyuni & Wibowo, 2020).

4. Growth of Scientific Attitudes and Learning Engagement

In addition to cognitive skills, PBL contributes to the growth of scientific attitudes and student engagement. The reviewed studies show that students become more motivated, curious, and responsible toward learning tasks when involved in problem-solving activities. Group discussions and collaborative inquiry foster positive learning environments that encourage openness, persistence, and environmental awareness. These attitudes are particularly important in ecosystem learning, which requires ethical and contextual understanding of environmental issues (Sari & Nugroho, 2020; Rahman & Yusof, 2022).

Discussion

The findings of this study confirm that Problem-Based Learning (PBL) is an effective instructional model for enhancing students' scientific thinking skills, particularly in science education at the junior high school level. The improvement in problem identification skills supports the constructivist learning theory, which emphasizes that knowledge is actively constructed by learners through interaction with their environment. In PBL, students are exposed to real-world problems that require observation, interpretation, and critical reflection, enabling them to develop deeper conceptual understanding (Creswell & Poth, 2018; Snyder, 2019).

The development of hypothesis formulation and inquiry skills reflects the core principles of scientific learning, where students are encouraged to engage in systematic investigation and evidence-based reasoning. This aligns with inquiry-based learning theory, which suggests that learning becomes more meaningful when students are involved in exploring questions and testing ideas rather than passively receiving information. PBL facilitates this process by positioning students as active problem solvers who must justify their assumptions and evaluate alternative explanations (Putri, Handayani, & Rahmawati, 2023; Arifin & Setiawan, 2022).

Furthermore, the enhancement of data analysis and reasoning abilities demonstrates that PBL supports higher-order thinking processes. From a cognitive perspective, PBL promotes analytical and evaluative thinking by requiring students to interpret data, synthesize information, and draw logical conclusions. This finding is consistent with previous research indicating that student-centered learning models are more effective in developing critical thinking compared to traditional teaching approaches (Leithwood & Jantzi, 2019; Wahyuni & Wibowo, 2020).

In terms of scientific attitudes and learning engagement, the results suggest that PBL contributes not only to cognitive development but also to affective and behavioral aspects of learning. Collaborative problem-solving activities foster motivation, curiosity, and responsibility, which are essential components of scientific character. In ecosystem learning, these attitudes are particularly important because they promote environmental awareness and ethical responsibility toward natural resources (Sari & Nugroho, 2020; Rahman & Yusof, 2022).

Overall, the discussion indicates that the effectiveness of PBL lies in its ability to integrate cognitive, social, and contextual learning processes. By combining real-life problems with collaborative inquiry, PBL creates meaningful learning experiences that strengthen students' scientific thinking

skills holistically. Therefore, PBL can be considered a pedagogically sound and theoretically grounded model for improving science learning outcomes in junior high school education.

CONCLUSION

This study concludes that Problem-Based Learning (PBL) is an effective instructional model for improving junior high school students' scientific thinking skills, particularly in ecosystem learning. Based on the synthesis of previous studies, PBL consistently enhances students' abilities in problem identification, hypothesis formulation, data analysis, and logical reasoning. These skills are fundamental components of scientific thinking and are essential for developing students' capacity to understand and solve complex scientific problems.

Furthermore, this study highlights that PBL not only contributes to cognitive development but also fosters positive scientific attitudes, such as curiosity, motivation, collaboration, and environmental awareness. Through real-world problem contexts and collaborative inquiry, students become more actively engaged in learning and develop deeper conceptual understanding of ecosystem topics.

Therefore, this study recommends that science teachers integrate Problem-Based Learning into classroom practices as an alternative pedagogical strategy to promote meaningful and student-centered learning. Future research is encouraged to combine literature-based findings with empirical classroom studies to further validate the effectiveness of PBL across different educational contexts and subject areas.

BIBLIOGRAPHY

Arifin, M., & Setiawan, D. (2022). Transformational leadership in education: A conceptual review. *Journal of Educational Leadership Studies, 5*(1), 45–60.

Barrows, H. S. (1996). Problem-based learning in medicine and beyond: A brief overview. *New Directions for Teaching and Learning, 68*, 3–12.

Bush, T. (2020). School leadership and management in the digital age. *Educational Management Administration & Leadership, 48*(3), 401–418.

Creswell, J. W., & Poth, C. N. (2018). *Qualitative inquiry and research design: Choosing among five approaches*. Thousand Oaks: Sage.

Hmelo-Silver, C. E. (2004). Problem-based learning: What and how do students learn? *Educational Psychology Review, 16*(3), 235–266.

Hung, W., Jonassen, D. H., & Liu, R. (2008). Problem-based learning. In J. M. Spector et al. (Eds.), *Handbook of Research on Educational Communications and Technology* (pp. 485–506). New York: Springer.

Kitchenham, B., & Charters, S. (2007). Guidelines for performing systematic literature reviews in software engineering. *EBSE Technical Report, 2*(1), 1–65.

Leithwood, K., & Jantzi, D. (2019). Transformational leadership effects on organizational conditions and student engagement. *Educational Administration Quarterly, 55*(4), 580–615.

Miles, M. B., Huberman, A. M., & Saldaña, J. (2014). *Qualitative data analysis: A methods sourcebook*. Thousand Oaks: Sage.

OECD. (2018). *PISA 2018 results: What students know and can do*. Paris: OECD Publishing.

Putri, L., Handayani, T., & Rahmawati, S. (2023). Hambatan implementasi pembelajaran digital di sekolah menengah. *Jurnal Pendidikan Modern, 9*(1), 21–35.

Rahman, M., & Yusof, N. (2022). Digital learning innovation in secondary education. *International Journal of Educational Technology, 7*(2), 98–110.

Sari, D., & Nugroho, A. (2020). Gaya kepemimpinan kepala sekolah dan inovasi pembelajaran. *Jurnal Administrasi Pendidikan, 27*(1), 52–64.

Savery, J. R. (2006). Overview of problem-based learning: Definitions and distinctions. *Interdisciplinary Journal of Problem-Based Learning, 1*(1), 9–20.

Snyder, H. (2019). Literature review as a research methodology. *Journal of Business Research, 104*, 333–339.

Sugiyono. (2019). *Metode penelitian pendidikan*. Bandung: Alfabeta.

Tan, O. S. (2003). *Problem-based learning innovation: Using problems to power learning in the 21st century.* Singapore: Thomson Learning.

Wahyuni, S., & Wibowo, A. (2020). Digital transformation in Indonesian education. *Jurnal Pendidikan dan Kebudayaan, 25*(4), 365–378.

Zed, M. (2014). *Metode penelitian kepustakaan*. Jakarta: Yayasan Pustaka Obor Indonesia.

Zimmerman, B. J. (2002). Becoming a self-regulated learner. *Theory into Practice, 41*(2), 64–70.