

Problem Based Learning as a Trigger for Critical Thinking Skills: A Literature Review

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ABSTRACT:

Purpose: This paper aims to analyze the influence of the Problem-Based Learning (PBL) model on the enhancement of students' critical thinking skills in biology learning. Critical thinking is essential for enabling students to understand biological concepts deeply, analyze natural phenomena, and solve problems logically.

Study design/methodology/approach: This study employs a literature review method using seven relevant national and international research articles. The review focuses on examining how PBL both in its pure form and when integrated with other approaches such as blended learning contributes to the development of critical thinking skills.

Findings: The findings indicate that PBL consistently has a positive impact on students' critical thinking skills. The PBL syntax, including problem orientation, organization, investigation, presentation of results, and evaluation, effectively stimulates students to think analytically, reflectively, and argumentatively. Moreover, PBL fosters a more contextual and meaningful learning environment, encouraging active engagement and deeper conceptual understanding.

Research limitations/implications – This review is limited to seven articles, which may not fully represent the broader scope of PBL implementation across diverse educational contexts. Future studies could incorporate a larger and more varied set of sources or conduct comparative analyses across different educational levels.

Originality/value: This study provides a synthesized understanding of how PBL supports the development of critical thinking in biology education, highlighting its relevance as a pedagogical model to prepare students for the demands of 21st-century skills. The integration of PBL with contemporary instructional approaches demonstrates its adaptability and enduring value in modern science education.

Keywords: *Problem Based Learning, Critical Thinking Skills, Biology Education, 21st Century Skills, Literature Review.*

I. INTRODUCTION

Critical thinking skills are important in the learning process because they encourage students to understand information in depth, analyze various problems, and make decisions based on logical reasoning (Greenstein, 2012; Sari et al., 2018). In biology lessons, these skills are essential because students are often confronted with various natural phenomena that require scientific reasoning, data analysis, and rational problem-solving (Agnesa & Rahmadana, 2022;

Rene et al., 2018; Sahil, 2022; Selaras et al., 2019). Several studies have shown that students' critical thinking skills still need to be improved (Purnamasari et al., 2017; Pramuji et al., 2020; Dari et al., 2020; Kurniahtunnisa et al., 2016; Adnyana, 2012). This condition can be influenced by various factors, such as the student's background, the learning environment, and the learning model (Mahanal, 2019; Kempa, 2006). According to Krisna (2013), students tend to demonstrate better critical thinking skills when presented with challenges or problems relevant to their lives.

One effective model for improving critical thinking skills is Problem-Based Learning (PBL). The PBL model positions students as active problem-solvers in contextually designed and challenging situations. This situation encourages students to find solutions independently or through group collaboration (Daryanto, 2014; Arends, 2012). Furthermore, the implementation of the PBL model also supports the creation of a more open and participatory learning environment. When students are given space to discuss, ask questions, and present arguments based on the basic data they have discovered, the learning process becomes more meaningful. They not only memorize concepts but also learn how to think, weigh options, and develop solutions based on evidence. This aligns with Arends' (2012) opinion, which states that PBL can stimulate students' metacognitive abilities. Thus, through group interaction and exploration of diverse learning resources, students can deepen their understanding of biology material while continuously honing their critical thinking skills.

Several studies have shown that implementing the PBL model can foster curiosity, increase self-confidence, and foster independence in learning (Dewi, 2020; Masrinah et al., 2019). This is because the steps in the PBL model, such as orienting students to the problem, organizing students for learning, individual/group guidance, developing and presenting results, and analyzing and evaluating the problem-solving process, directly encourage students to think more deeply. They learn to assess information, construct arguments, and make reasoned decisions. This process is closely related to critical thinking skills. Furthermore, because the PBL model is linked to real-world problems, learning becomes more meaningful (Arsih et al., 2021). Positive results from the use of the PBL model have also been found in many biology subjects, such as environmental pollution (Hasanah et al., 2021), biodiversity (Erwanto, 2020), and the reproductive system (Anggraeni et al., 2018). This literature review aims to further examine how the PBL model can influence the improvement of students' critical thinking skills in biology learning.

II. METHOD

This study used a literature review method. This literature review utilized a number of articles from accredited national and international journals, which can be found on Google Scholar, Science Direct, and Eric. The articles reviewed were articles that met the criteria of being research articles in Indonesian and English, meeting the criteria of the search keywords used, having titles and content relevant to the research objectives, and free access. The articles analyzed were published between 2017 and 2025. This study used a content analysis method to analyze the data. The analysis process was carried out by in-depth reviewing various literature sources, both from national and international journals, that discussed the influence of the Problem-Based Learning model on students' critical thinking skills. The total number of articles obtained was filtered according to the inclusion criteria, resulting in the final result of 7 articles reviewed.

III. RESULT

Table 1. Literature Review Articles on the Effect of Problem-Based Learning Models on Students' Critical Thinking Skills

Cocce	Author	Research Title	Research Results
A1	(Habibah et al., 2022)	The Effect of a Blended Learning-Based Problem-Based Learning Model on the Critical Thinking Skills of Grade XI Students at SMAN 2 Mataram	The application of a blended learning-based PBL model is better than conventional methods in improving the critical thinking skills of grade XI science students at SMAN 2 Mataram.
A2	(Marhamah et al., 2020)	The Effect of a Problem-Based Learning Model on Critical Thinking Skills	There is an effect of the problem-based learning model on the critical thinking skills of grade XI science students at SMAN 1 Praya Barat Daya in the 2018/2019 academic year. This proves that different treatments will produce different results.
A3	(Yarmalinda et al., 2020)	The Effect of a Problem-Based Learning Model on Students' Analytical and Critical Thinking Skills in Ecology	The problem-based learning model has a significant effect on students' critical thinking skills.
A4	(Aryawati et al., 2020)	The Effect of the Problem-Based Learning Model on Critical Thinking Skills in Biology Learning, Reviewed from the Cognitive Styles of Grade 10 High School Students	here are differences in critical thinking skills between students who learn using the problem-based learning model and those who learn using the direct instruction model. The problem-based learning model has been proven effective in improving students' critical thinking skills.
A5	(Setiawan et al., 2017)	The Effect of the Problem-Based Learning Model Combined with Student Facilitator and Explainer on the Critical Thinking Skills of Grade 10 Students of Sman 6 Kediri on the Subject of Fungi	There is a significant effect of the Problem-Based Learning model combined with Student Facilitator and Explainer on students' critical thinking skills in the topic of the Kingdom of Fungi.
A6	(Ananda et al., 2022)	Application of the Problem-Based Learning Model to Improve Students' Critical Thinking Skills.	Learning using the problem-based learning model is very effective in improving students' critical thinking skills.

Cocoe	Author	Research Title	Research Results
A7	(Maulina et al., 2022)	The Effect of Mixed-Based Problem Based Learning on Critical Thinking Skills of Class X Students of SMAN 1 Kuripan	There is a positive influence of mixed-based problem based learning on critical thinking and literacy skills of class X students of SMAN 1 Kuripan in the 2022/2023 academic year.

Based on the results of a study of seven articles analyzed (Habibah et al., 2022; Marhamah et al., 2020; Yarmalinda et al., 2020; Aryawati et al., 2020; Setiawan et al., 2017; Ananda et al., 2022; Maulina et al., 2022), it can be seen that the application of the Problem-Based Learning (PBL) model has proven effective in improving students' critical thinking skills. This is inseparable from the characteristics of PBL, which is oriented towards solving real problems and encouraging students to be actively involved in the entire learning process. The PBL model not only provides material but also positions students as subjects who actively seek solutions, explore information, and evaluate the processes they have carried out. All articles analyzed show an increase in critical thinking skills when students are involved in problem-based learning, both in the form of pure PBL or combined with other approaches such as blended learning or Student Facilitator and Explainer.

IV. DISCUSSION

In article A1 (Habibah et al., 2022), the implementation of a blended learning-based PBL model demonstrated significant success in improving the critical thinking skills of eleventh-grade students at SMAN 2 Mataram. In the problem-orientation phase, students were guided to understand real-life problems. This activity fostered initial interpretation and analysis skills, requiring them to identify key elements of the presented problem. Furthermore, as they entered the guided individual and group investigation phase, students actively sought data, critiqued information, and constructed logical understandings. This phase fostered strong information evaluation and inference skills, as they had to independently draw conclusions from their investigations. Explanatory skills were strengthened when students presented their research findings both offline and online, demonstrating that blended learning enriched their scientific communication process.

Article A2 (Marhamah et al., 2020) demonstrated that organizing students for learning was crucial for fostering group collaboration and communication. In the context of SMAN 1 Praya Barat Daya, students demonstrated improvements in critical thinking through systematically guided group discussions. This process significantly supported the explanation and evaluation indicators, as students discussed, expressed opinions, and considered alternative solutions emerging within the group. Furthermore, the guided inquiry phase provided a space for students to hone their analytical and inference skills through the collection and processing of information based on empirical data. Students' critical thinking skills developed through the dynamic question-and-answer process and reflective interactions within the study groups.

In article A3 (Yarmalinda et al., 2020), students' analytical and critical thinking skills improved significantly when the PBL model was applied to ecology material. The guided inquiry phase was the primary focus of this study, where students were given the freedom to develop investigation strategies and select relevant information sources. This process strengthened the analysis and evaluation indicators, as students had to assess the credibility of sources and compare data. The development and presentation phase of results was also crucial in developing explanatory skills, as students presented their analysis in a class forum, allowing for

clarification and strengthening of arguments. Critical thinking is strengthened by the requirement to present arguments based on evidence and systematic logic.

Article A4 (Aryawati et al., 2020) focuses specifically on the final stage of PBL, namely analyzing and evaluating the problem-solving process. This research was conducted with students' cognitive styles in mind, and the results show that reflection on the learning process helps students improve their evaluation and metacognitive skills. Students are not only encouraged to assess the effectiveness of their solutions but also to review their thinking patterns, investigative approaches, and decisions. This reflection enables them to improve the quality of future problem-solving and develop more adaptive and systematic critical thinking strategies.

Article A5 (Setiawan et al., 2017) combines the PBL model with the Student Facilitator and Explainer (SFAE) model in teaching the Kingdom of Fungi. The development and presentation stages are optimized through students' active participation in systematically explaining the problem-solving process to their peers. Interaction between students in discussion forums strengthens indicators of explanation, evaluation, and inference. The combination of PBL and SFAE creates collaborative learning that allows students to critique each other's thinking, receive input, and develop deeper understanding through clarification and feedback.

Article A6 (Ananda et al., 2022) emphasizes the power of PBL in shaping students' thinking processes from the early stages of learning. In the problem-oriented stage, students are directly confronted with real-life challenges, thus developing their interpretation and analysis skills from an early age. The investigative process in the inquiry stage provides significant opportunities for students to evaluate evidence, construct arguments, and draw logical conclusions (inferences). This research confirms that PBL encourages students to take ownership of their learning process, making them more critical and reflective about the decisions they make during the investigation.

Meanwhile, article A7 (Maulina et al., 2022) showed that the blended learning-based PBL model can still significantly improve critical thinking skills. The orientation phase is conducted through digital media designed to be interactive and engaging, giving students flexibility in absorbing initial information. Discussions in online and offline forums create space for developing explanation and evaluation skills, while the inquiry phase encourages students to assess the validity of sources and develop structured thinking. The final phase, developing results, encourages students to develop logical, coherent, and evidence-based reports and presentations. These results reinforce the PBL model's ability to create a quality learning experience.

Overall, the seven articles analyzed demonstrate that all aspects of the PBL model problem orientation, student organization, investigation guidance, development and presentation of results, and evaluation of the problem-solving process have a direct and significant relationship with strengthening critical thinking skills indicators. Each aspect of the PBL model complements the others, forming an active and reflective learning cycle. The PBL model encourages students not only to understand the material but also to develop adaptive critical thinking patterns, be open to arguments, and be able to make decisions based on logic and data. Therefore, PBL is highly relevant for implementation in 21st-century learning, which requires students to master not only content but also higher-order thinking skills.

Overall, the syntax of Problem-Based Learning (PBL) directly supports the achievement of every indicator of critical thinking skills. Each stage in the PBL syntax, from problem orientation, data collection, information analysis, to the development and presentation of

solutions, is closely related to important aspects of critical thinking, such as identifying problems, analyzing arguments, evaluating information, and drawing logical conclusions. Thus, through a systematic, problem-based process, PBL can improve all indicators of students' critical thinking. Research by Ananda et al. (2022) and Maulina et al. (2022) also shows that the effectiveness of the PBL model is not limited to face-to-face learning but has also proven successful in hybrid approaches. This confirms that the flexibility of PBL makes it highly relevant for application in biology learning. Therefore, it can be concluded that the implementation of PBL significantly encourages the improvement of students' critical thinking skills.

V. CONCLUSION

The achievement of students' critical thinking skills indicators, including interpretation, analysis, evaluation, inference, and explanation, occurred significantly due to the implementation of the Problem Based Learning (PBL) model. The PBL model provides space for students to interpret information accurately (interpretation), describe problems logically (analysis), assess the accuracy of arguments (evaluation), draw conclusions based on evidence (inference), and explain the results of their thinking coherently and rationally (explanation). Through the PBL syntax that positions students as active subjects in solving real problems, it is proven that students' critical thinking skills improve.

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