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Using problem-based learning to enhance critical thinking in university classrooms

Nguyen Thi Thi

National Academy of Education Management, Hanoi city, Vietnam
Email: thitapchi@gmail.com | thitapchinaem@gmail.com
<https://orcid.org/0009-0008-0274-5803>

Nguyen Thi Le Thuy

Tay Son Primary School, Hanoi city, Vietnam

Vu Thi Thu Ha

Le Ngoc Han Secondary School, Hanoi city, Vietnam

Abstract---This paper provides an in-depth study on how Problem-Based Learning can be employed to enhance students' critical thinking abilities in the university educational setting. By defining and exploring the concept of critical thinking, introducing PBL and its role in fostering this skill, the paper offers a comprehensive and insightful understanding of the relationship between these two concepts. Through synthesizing previous research and analyzing specific factors within the PBL framework, the paper elucidates that PBL is not merely a teaching method but also a powerful tool to encourage and develop students' critical thinking. Additionally, the paper discusses approaches to evaluating critical thinking in the PBL environment and emphasizes the opportunities and challenges in expanding PBL application across different disciplines and educational contexts. By examining both aspects, the paper provides practical guidance for educators and researchers on optimizing PBL to enhance students' critical thinking skills in university education.

Keywords---Problem-Based Learning, Critical Thinking, University Education, Effectiveness Assessment, PBL Expansion.

1. Introduction

In the context of higher education, critical thinking plays an essential role in the development of students' reasoning, analytical, and problem-solving skills. The

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Corresponding author: Thi, N. T., Email: thitapchi@gmail.com

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development of critical thinking is not only an educational goal but also a determining factor for academic success and personal growth in the real world. This is evident through the increasing focus on teaching and assessment methods aimed at fostering critical thinking in university settings.

One of the highly regarded teaching methods for enhancing critical thinking is Problem-Based Learning (PBL). PBL focuses not only on knowledge transmission but also encourages students to engage with and solve real-world problems. Through this process, students are motivated to develop critical thinking by seeking, analyzing, and evaluating information to make logical and constructive decisions.

Overall, PBL is considered a flexible and effective teaching method that helps students not only master knowledge but also develop critical thinking skills. Previous studies have demonstrated a positive relationship between the application of PBL and the development of critical thinking. For instance, the research by D'Alessio et al. (2019) on the effectiveness of critical thinking on the learning outcomes of EMBA students shows a positive connection between critical thinking and academic achievement. Similarly, Fong et al. (2017) studied critical thinking and academic performance in students and proposed a strong link between critical thinking and academic success.

This raises the question of how to effectively apply PBL to enhance critical thinking in the university environment. In this context, this study will focus on analyzing the theoretical foundations of PBL and its role in developing critical thinking in university students. In doing so, we can gain a better understanding of how PBL can be designed and implemented to optimize the enhancement of critical thinking in higher education.

2. Theoretical Foundations

2.1. Definition and Concept of Critical Thinking in the Context of Higher Education

In the context of higher education, critical thinking is an essential ability that not only shapes academic success but also reflects the depth of understanding and the ability to apply knowledge in real-world situations. Critical thinking involves not only reasoning and logical analysis but also includes the ability to evaluate, process information, and draw constructive conclusions. This highlights the important role of critical thinking in developing reasoning skills, which serve as the foundation for students' comprehensive development in higher education.

According to D'Alessio et al. (2019), critical thinking has a significant impact on students' academic performance, with the development of critical thinking helping them achieve higher academic outcomes. Similarly, Fong et al. (2017) also demonstrated a positive relationship between critical thinking and academic success. This further emphasizes the importance of developing critical thinking in higher education settings.

Meanwhile, Akhdinirwanto et al. (2020) studied the use of PBL method to enhance critical thinking skills among middle school students. The results of this

study indicated that PBL, combined with debate, can be an effective model for enhancing students' critical thinking. Similarly, Amin et al. (2020) also mentioned the positive impact of PBL on students' critical thinking skills and environmental attitudes.

In this context, PBL is not only a teaching method but also a learning framework that can be used to encourage reasoning and analysis among students. For example, Anesa (2021) studied the effectiveness of a PBL-based module on classical genetic materials to improve students' critical thinking skills. These studies provide evidence of the importance of PBL in developing critical thinking in higher education.

In addition, Arini et al. (2017) investigated the use of mind mapping strategies in essay writing, highlighting the role of creative learning techniques in fostering critical thinking. This emphasizes the variety of teaching and assessment methods that can be employed to encourage critical thinking in higher education settings.

2.2. Problem-Based Learning Method and Theoretical Foundations

PBL has become a powerful tool in developing students' critical thinking skills in higher education. PBL is a teaching method that focuses on solving real-world, complex problems rather than merely transmitting knowledge. Through PBL, students are encouraged to pose questions, seek information, analyze problems, and propose solutions. In this process, they not only master knowledge but also develop reasoning, logical, and critical thinking skills.

The theoretical foundation of PBL reflects the philosophy of constructing knowledge through solving real-world problems, an approach developed by John Dewey and Jean Piaget. According to this philosophy, learners learn best when they are motivated to apply knowledge to real situations, rather than just accumulating information without a specific purpose. PBL also reflects a social philosophy of constructing knowledge through teamwork and collaboration, aimed at developing communication and teamwork skills.

Studies have demonstrated the effectiveness of PBL in enhancing students' critical thinking. For example, the study by Akhdinirwanto et al. (2020) on applying PBL with argumentation as a hypothetical model to enhance critical thinking skills among middle school students showed significant improvement in students' critical thinking. Similarly, the study by Amin et al. (2020) on the impact of PBL on critical thinking skills and environmental attitudes also concluded positively about the effectiveness of this method.

Key elements of PBL include designing appropriate problems, guiding and supporting students in the problem-solving process, as well as providing timely assessments and feedback. At the same time, integrating technology and digital resources into the PBL learning process plays an important role in creating a diverse and engaging learning environment.

Overall, PBL is not only a teaching method but also an educational philosophy, with the goal of developing students' critical thinking and problem-solving skills through solving real-world, complex problems. The combination of PBL and theoretical principles of critical thinking is key to building a dynamic, creative, and developmental learning environment.

2.3. The Relationship Between Problem-Based Learning and the Development of Critical Thinking

The PBL method is an important aspect of modern education and is considered a powerful tool for developing critical thinking in university students. PBL not only focuses on the transmission of knowledge but also promotes the development of reasoning, analytical, and evaluative skills—key components of critical thinking. One of the ways PBL influences the development of students' critical thinking is by presenting and solving real-world and complex problems. When students are faced with these challenges, they are not simply receiving information; they must apply logical and creative thinking to find effective solutions. By engaging with and solving real-life situations, students are challenged to develop critical thinking skills, including logical reasoning, evaluating the feasibility of alternatives, and actively processing information.

The theoretical foundation of PBL also contains essential elements related to critical thinking. The theory of knowledge construction, a core component of PBL's theoretical basis, emphasizes that learners build new knowledge based on their existing knowledge and real-world experiences. In this process, learners do not merely memorize information but must examine and assess it, thereby reinforcing their critical thinking skills.

The study by Fadilla et al. (2021) clearly highlighted the positive impact of PBL on the development of critical thinking. The results of the study showed that students participating in PBL activities tend to have better reasoning and analytical skills compared to students engaged in traditional teaching methods. Similarly, the research by Franco et al. (2018) demonstrated the correlation between participation in PBL activities and the development of critical thinking skills.

Moreover, PBL creates an active learning environment that supports the development of critical thinking. Through group activities, students have the opportunity to exchange ideas, discuss, and present different perspectives, thereby broadening their viewpoints and improving their reasoning and evaluative abilities.

In summary, the relationship between PBL and the development of critical thinking is both strong and positive. PBL is not only an effective teaching method but also a crucial tool for developing university students' critical thinking skills, thereby preparing them for success in life and future careers.

3. Research Method

This study uses the bibliometric approach to evaluate and synthesize relevant research on Problem-Based Learning and its impact on the development of critical thinking in university students. The bibliometric method helps analyze previous studies, providing an overview of the effectiveness of PBL and the factors influencing critical thinking development in higher education settings.

Defining the Research Question: The main research question of the paper is: "How does the PBL method affect the development of critical thinking in university students?"

Selection of Literature and Sources: The research materials were chosen from scientific databases such as Google Scholar, JSTOR, ERIC, and reputable education journals. The selected literature includes research papers, books, theses, and reports related to PBL and critical thinking. Keywords used for the search include "Problem-Based Learning", "Critical Thinking", "Higher Education", "Student Learning", "Effectiveness of PBL", and "Developing Critical Thinking Skills."

Screening and Selecting Literature: Literature was selected based on criteria such as recency (studies published within the past 5-10 years), reliability of the source (peer-reviewed studies from reputable journals and research institutions), and relevance to the research question. Studies related to the impact of PBL on the development of critical thinking in university students were the focus of the bibliometric approach.

Analysis and Synthesis of Results: The studies were categorized and analyzed according to main themes: the impact of PBL on critical thinking, the development of critical thinking skills through PBL, and the factors that support or hinder this process.

The studies were compared and evaluated based on the results of PBL's impact on critical thinking development, providing insights into the effectiveness and key factors that optimize the PBL method.

Assessing Research Quality: The studies were assessed based on the quality of the research methodology, reliability, and accuracy of the results. Studies with clear methodologies, well-designed research, and reliable data were prioritized in the synthesis process.

Synthesis and Conclusion: After analyzing the studies, the results were synthesized to provide an overview of the impact of PBL on critical thinking in higher education. Successful factors and challenges in implementing PBL were also identified, leading to recommendations for applying PBL in various educational contexts.

4. PBL Model and Critical Thinking

4.1. A Specific Analysis of How the PBL Model Can Be Applied to Encourage Critical Thinking

The PBL model offers students the opportunity to engage with complex, real-world problems, thereby encouraging the development of critical thinking. First, in the PBL model, students are often assigned specific tasks or problems to solve. This process typically begins with students analyzing the problem, gathering relevant information, and identifying key aspects of the issue. Through participation in this process, students must apply critical thinking skills to ask questions, reason logically, and propose solutions.

Another crucial element of the PBL model is the organization and facilitation of discussions and group collaboration sessions. In these sessions, students are encouraged to exchange ideas, discuss, and critique each other's solutions and perspectives. By participating in such group activities, students not only learn from their peers' opinions and viewpoints but also develop their own ability to think critically and evaluate independently.

Additionally, the PBL model often requires students to engage in the process of questioning and information searching. This not only helps students expand their knowledge but also encourages them to develop critical thinking skills in analyzing and assessing information. In this way, the PBL model is not just an educational tool but also a process that creates vital opportunities for the development of students' critical thinking.

4.2. Specific Factors in the PBL Model Contributing to the Development of Students' Critical Thinking

In the PBL model, there are several specific factors that play an important role in the development of students' critical thinking:

The Problem-Solving Process: In PBL, students face complex, real-world problems that require them to use logical and creative thinking to solve. This process involves analyzing the problem, gathering information, evaluating options, and proposing solutions that are both logical and feasible. By engaging in this process, students develop critical thinking and problem-solving skills in an active manner.

Learning Through Discussion and Group Collaboration: The learning and working environment in PBL facilitates discussion, exchange of ideas, and development of multidimensional viewpoints. By participating in discussion sessions, students learn from their peers' opinions and experiences, while also having to explain and defend their own views. This encourages students to develop skills in listening, making logical arguments, and working effectively within a team.

The Process of Questioning and Information Seeking: PBL encourages students to independently seek information and ask questions to better understand the problem at hand. By searching for information from a variety of sources, students must assess the reliability of the information, distinguish between relevant and irrelevant information, and thereby develop critical thinking skills and an active approach to learning.

Access to Teacher Guidance: In the PBL process, teachers act as facilitators or guides. Receiving guidance from teachers helps students develop the ability to assess information, make decisions, and solve problems with confidence. Feedback and support from the teacher also help students gain a deeper understanding of the critical thinking process and how to apply it in practice.

5. The Effectiveness of the Problem-Based Learning Approach in Enhancing Critical Thinking

5.1. Previous Research on the Effectiveness of Problem-Based Learning in Developing Critical Thinking

The PBL approach has attracted the attention of many educational researchers due to its potential in enhancing students' critical thinking. Previous studies have reflected the effectiveness of PBL in developing the critical thinking skills that are essential for students.

A representative study by Fadilla et al. (2021) examined the impact of PBL on students' critical thinking skills. The results of this study indicated that PBL can significantly improve students' reasoning and analytical abilities. By confronting and solving real-world problems, students are encouraged to apply critical thinking skills to generate effective solutions.

Another study by Franco et al. (2018) focused on the role of PBL in encouraging creativity and critical thinking among university students. The results of this study showed that PBL not only helps students develop critical thinking skills but also fosters creativity by promoting the search for and proposal of diverse solutions to problems.

Furthermore, the study by Akhdinirwanto et al. (2020) emphasized the effectiveness of PBL in enhancing critical thinking skills among high school students. Through engaging in problem-solving and debating with peers, students not only developed their logical thinking but also learned how to evaluate and argue logically and substantively.

5.2. Analysis of the Strengths and Limitations of the Problem-Based Learning Approach in Enhancing Critical Thinking

The PBL approach is not only a useful tool for enhancing students' critical thinking but also offers significant benefits in the learning process. Below is a detailed analysis of the strengths and limitations of PBL:

Strengths:

Encourages Self-Learning: One notable strength of PBL is that it encourages self-learning. Instead of the teacher traditionally delivering knowledge, PBL creates opportunities for students to explore and discover by solving real-world problems. By independently seeking and mastering knowledge, students develop self-learning skills and critical thinking.

Develops Problem-Solving Skills: PBL focuses on solving complex, real-world problems, which helps students develop logical thinking and critical thinking skills. This problem-solving process not only allows students to apply the knowledge they have learned but also encourages them to search for and evaluate effective solutions.

Learning from Peers: PBL is often organized through group activities, which allow students to exchange ideas and learn from different perspectives. Engaging in discussions and group exercises helps expand students' thinking, thereby developing their ability to critically evaluate and process information flexibly.

Limitations:

Time and Effort Intensive: Implementing PBL requires considerable time and effort from both instructors and students. Preparing problems and managing the learning process can be more time-consuming compared to traditional teaching methods.

Requires Effective Guidance Skills: To ensure that the PBL process is effective, instructors need strong guidance skills. They must be skilled in helping students search for information, analyze problems, propose solutions, and provide necessary support during the learning process.

6. Evaluation and Expansion

6.1. How to Evaluate Critical Thinking in a PBL Environment

To ensure that PBL truly contributes to the development of students' critical thinking, evaluations need to be carefully designed and multifaceted. Below are some methods for evaluating critical thinking in a PBL environment:

Problem-Solving Assignments: In the PBL process, students are often assigned real-world or hypothetical problems to solve. Evaluation can focus on the student's ability to analyze the problem, identify causes and consequences, and propose feasible and logical solutions. Evaluation may also consider how the student approaches and solves the problem, including the logic of their thinking, their ability to apply knowledge, and their practical problem-solving skills.

Discussions and Presentations: PBL often requires students to engage in group discussions to exchange ideas and develop their thinking. Evaluation can measure a student's contribution to discussions, their ability to listen and respond to peers' viewpoints, as well as their ability to express opinions clearly and persuasively. Presentation and argumentation skills can be assessed through presentations or reports, where students must present and defend their opinions before the class and a panel of evaluators.

Products or Projects: A key aspect of PBL is that students must produce products or projects after conducting research and engaging in discussions. Evaluation can focus on the quality and creativity of the product or project, as well as the ability to apply knowledge to solve specific challenges. The evaluation may also consider the level of collaboration and group organization involved in the production of the product or project.

These evaluation methods provide a comprehensive view of how students' critical thinking develops in a PBL environment, from problem-solving abilities to communication skills and the production of knowledge.

6.2. Opportunities and Challenges in Expanding the Application of PBL to Enhance Critical Thinking Across Different Disciplines and Educational Contexts

Opportunities:

Expanding the application of PBL to various subjects offers many opportunities for students to develop critical thinking:

Interdisciplinary Integration: PBL is not only suitable for science subjects but can also be applied in fields such as business, medicine, sociology, and the arts. This helps students understand and apply critical thinking across various fields, opening up opportunities for multidimensional learning and development.

Promotes Creativity: PBL encourages students to seek creative solutions to complex problems. This helps them develop creative and critical thinking to come up with innovative and effective solutions.

Building Communication Skills: Participating in group activities and discussions within PBL helps students develop effective communication skills, from presenting ideas to listening and interacting with peers.

Comprehensive Critical Thinking Development: PBL not only focuses on problem-solving but also encourages questioning, analyzing information, and evaluating solutions. This helps students develop flexible and comprehensive critical thinking.

Challenges:

Although it offers many opportunities, expanding the application of PBL also faces several challenges:

Time and Resource Investment: Implementing PBL requires significant investment in terms of time, resources, and effort from both instructors and students. Preparing real-world problems, guiding group activities, and evaluating outcomes require considerable time and effort.

Infrastructure Challenges: For schools with limited infrastructure, implementing PBL can be difficult due to the lack of appropriate learning spaces and resources.

Training and Support for Instructors: To effectively apply PBL, instructors need to be trained and supported both in terms of teaching methodology and guidance skills. This requires investment from educational institutions to develop and support faculty members.

In conclusion, while expanding the application of PBL presents many opportunities, it also demands significant investment and support to overcome challenges. However, with commitment and effort, PBL remains an effective tool for enhancing students' critical thinking in various educational contexts.

7. Conclusion

In a higher education environment, developing critical thinking is an essential factor that not only helps students engage deeply with knowledge but also prepares them to be lifelong learners. The PBL method has been proven to be an effective tool in enhancing students' critical thinking.

This study has discussed the importance of critical thinking in higher education and introduced the PBL method and its role in developing critical thinking. The

PBL model not only encourages self-learning and develops students' problem-solving skills but also creates opportunities for students to learn from their peers. Furthermore, the study analyzed the relationship between PBL and the development of critical thinking, highlighting specific elements in the PBL model that contribute to developing this skill. It also summarized previous studies on the effectiveness of PBL in enhancing critical thinking while analyzing the strengths and limitations of this approach.

In conclusion, the application of PBL is an effective means of developing students' critical thinking in higher education. However, promoting this development requires investment and effort from both instructors and students, as well as flexibility and creativity in applying this method across various educational contexts.

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