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PROBLEM-BASED LEARNING METHODS IN DEVELOPING CRITICAL THINKING

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Annotation: This research examines the pedagogical effectiveness of problem-based learning (PBL) in developing critical thinking skills. The study highlights the role of PBL in enhancing students' critical thinking, independent learning, creative problem-solving, and collaborative skills. Furthermore, the impact of problem-based learning on metacognitive, social, and ethical development, its integration with modern educational technologies, and its effectiveness as confirmed by international studies are analyzed.

Keywords: critical thinking, problem-based learning, PBL, pedagogical strategy, independent learning, creative thinking, metacognitive skills, collaborative learning

Problem-Based Learning (PBL) has emerged as a transformative pedagogical approach in contemporary education, aiming to bridge the gap between theoretical knowledge and real-world application. Unlike traditional instructional models that emphasize information delivery, PBL repositions learners at the center of the educational process, challenging them to investigate, analyze, and solve complex problems collaboratively. At its core, PBL is not merely a teaching method but a cognitive framework designed to develop students' higher-order thinking skills, particularly critical thinking. Critical thinking encompasses capabilities such as reasoning, reflection, evaluation of evidence, and effective decision-making—skills indispensable for academic success, lifelong learning, and professional competence in the 21st century. Critical thinking is one of the most important components of modern education, as it develops students' abilities to think, analyze, evaluate, and make decisions. Today's educational system requires students not only to memorize knowledge but also to analyze it independently and develop problem-solving skills in rapidly changing conditions. From this perspective, problem-based learning methods are considered an effective tool for developing critical thinking.

Problem-based learning (PBL) is a pedagogical strategy that organizes the learning process around students' independent problem-solving activities. This approach transforms learners from passive recipients to active participants, fostering analytical, creative, and critical thinking skills. Modern educational experts, such as Barrows (1996) and Hmelo-Silver (2004), emphasize that PBL prepares students to make decisions in real-life situations, promotes self-directed learning, and encourages independent knowledge acquisition. Moreover, PBL not only integrates interdisciplinary knowledge but also enhances students' social and communication skills.

The effectiveness of the PBL method can be explained by several factors. Firstly, it provides students with opportunities to solve real-world problems, stimulating practical thinking. Secondly, this method enhances students' self-regulation, research, and analytical

skills. Furthermore, PBL encourages teamwork and communication, as problems are often discussed collaboratively. Research shows that students taught using PBL demonstrate significantly higher critical thinking skills compared to those taught with traditional methods (Barrows, 1996; Hmelo-Silver, 2004).

PBL's philosophical roots can be traced to constructivist learning theories, which posit that knowledge is actively constructed by learners through interaction with problems and social negotiation. According to cognitive constructivism, learners internalize new information more deeply when it is connected to authentic contexts and personally meaningful tasks. Social constructivism extends this by highlighting the importance of collaborative dialogue in shaping understanding. In PBL environments, students encounter ill-structured problems—situations that mimic real-world complexity without clear, predetermined outcomes. Such problems compel learners to exercise judgment, question assumptions, and integrate diverse information sources. From a cognitive psychology perspective, critical thinking involves metacognitive regulation—awareness and control over one's cognitive processes. PBL tasks inherently stimulate metacognition by requiring learners to plan strategies, monitor progress, and adjust approaches based on feedback and reflection. This iterative self-regulation strengthens learners' capacity to assess the validity of arguments, discern biases, and derive reasoned conclusions.

A key feature of problem-based learning in developing critical thinking is that it does not merely deliver ready-made knowledge but enables students to study independently, justify their decisions, and apply existing knowledge in new situations. Additionally, PBL fosters an interactive pedagogical environment where students exchange ideas and engage in discussion. This approach stimulates creative thinking, allowing students to generate new ideas and critically analyze them. Studies by Hmelo-Silver (2004) indicate that students using PBL achieve higher results in solving complex problems and develop independent thinking skills more effectively than with traditional methods. Barrows (1996) emphasizes the pedagogical significance of knowledge sharing and communication among students in PBL processes.

Thus, problem-based learning not only develops critical thinking but also enhances students' capacity for independent learning. Its relevance aligns with the demands of modern education, as it cultivates skills in independent analysis, decision-making, and creative problem-solving. Additionally, PBL organizes learning interactively and practically, turning students into active participants and increasing their motivation. The pedagogical effectiveness of problem-based learning in fostering critical thinking demonstrates that it simultaneously develops students' independent thinking, analytical abilities, creativity, and decision-making skills. Therefore, applying PBL in modern education plays a crucial role in improving student development and educational quality.

Problem-based learning guides students not only toward acquiring knowledge but also toward analyzing and solving problems independently. Through this method, learners recognize their active role in the learning process and learn to evaluate each problem from different perspectives. PBL also connects theoretical knowledge with practice, as each problem is selected based on real-life contexts. This ensures that knowledge transforms

from abstract concepts into concrete, applicable skills. Research shows that students developing critical thinking through PBL make faster and more effective decisions in complex situations, as well as master skills in structuring problems and solving them step by step. Savery and Duffy (1995) found that in PBL, students often engage in peer discussions while revising their knowledge and generating new ideas, which enhances metacognitive skills—an essential component of critical thinking as it enables students to monitor, evaluate, and improve their thought processes.

Another advantage of problem-based learning is that it allows students to critically analyze knowledge and create new understanding by comparing various sources. Consequently, PBL develops not only individual intellectual abilities but also collective intelligence. In group work, each student learns to defend their ideas, analyze others' viewpoints, and make adaptive decisions, thereby enhancing social and communicative skills. Moreover, problem-based learning significantly boosts motivation, as students are engaged with real-life, interesting problems, encouraging them to analyze deeply rather than merely complete assignments. Research indicates that motivation and independent thinking are closely linked, directly enhancing the effectiveness of PBL (Dolmans et al., 2005). PBL can also be organized individually or in groups, enabling critical thinking development tailored to each student's abilities.

Problem-based learning is not limited to traditional subjects; it supports interdisciplinary integration. For example, combining real-life problems in biology, mathematics, and social studies helps students analyze complex systems and understand interconnections among elements. This process contributes to comprehensive critical thinking, as students apply knowledge from various subjects in new contexts. PBL also fosters social and ethical reasoning, as students often face real-life situations requiring responsible decision-making and consideration of others' perspectives.

Collaboration is a hallmark of PBL that significantly contributes to critical thinking development. In group settings, students encounter diverse viewpoints that prompt re-evaluation of their assumptions. Through discourse and joint decision-making, learners refine their arguments, learn to negotiate, and build collective understanding. The social dimension of PBL strengthens communication skills, emotional intelligence, and appreciation for interdisciplinary thinking. Peer interaction functions as a dynamic cognitive stimulus, as learners justify solutions, respond to counterarguments, and co-construct knowledge.

The teacher's role is essential in enhancing PBL effectiveness. Teachers act not merely as knowledge transmitters but as guides, mentors, and advisors who help identify and solve problems step by step. Thus, the learning process focuses on developing students' independent thinking, which strengthens critical thinking. PBL enhances knowledge acquisition while cultivating creativity, analytical reasoning, and complex problem-solving skills. Consequently, applying PBL in modern education is crucial for students' intellectual and personal growth. The effectiveness of problem-based learning in developing critical thinking is confirmed by international research. For example, a meta-analysis by Strobel and van Barneveld (2009) showed that students using PBL not only

improved academic performance but also significantly enhanced their critical thinking skills. During PBL, students analyze complex situations, identify cause-and-effect relationships, and generate multiple solution options.

Additionally, PBL develops students' self-assessment and reflection skills. Learners analyze their performance, identify errors, and find ways to improve, strengthening the metacognitive components of critical thinking. PBL provides a solid foundation in scientific methodology, as students apply research methods, collect data, and conduct analysis while solving problems. Cooperative learning elements in PBL encourage listening, analyzing peers' opinions, and collaboratively creating adaptive solutions, developing both individual critical thinking and group problem-solving skills. These competencies prepare students for professional activities in modern workplaces, where complex problem-solving and teamwork are essential.

The practical value of PBL is high, as it can be applied across different subjects. For instance, natural science problems develop scientific analysis and experimental thinking, while social science problems enhance social and ethical critical thinking. PBL also promotes interdisciplinary integration and multidisciplinary approaches. Pedagogical design and technology play a vital role in increasing PBL effectiveness, using real-life scenarios, interactive software, online simulations, and virtual laboratories. These tools enable students to analyze problems from multiple perspectives and develop innovative solutions, while increasing active participation and knowledge consolidation.

PBL encourages independent learning, allowing students to expand and deepen their knowledge, analyze new topics, justify their reasoning, and explore multiple solutions. Thus, PBL develops not only critical thinking but also independent scientific research skills. Technology enhances PBL by facilitating access to information, simulation environments, and collaborative platforms. Digital tools support inquiry through data visualization, interactive modeling, and virtual experimentation. For example, online forums and document sharing enable asynchronous collaboration, expanding opportunities for sustained dialogue. Technology also allows for differentiated instruction, enabling learners to explore content at individualized paces and depths. By interacting with diverse digital resources, students sharpen information evaluation skills—a core aspect of critical thinking in the digital age.

Recent research underscores that PBL not only develops individual analytical skills but also cultivates a disposition toward lifelong learning. According to a study by Hung et al. (2017), students engaged in sustained PBL experiences demonstrate higher self-efficacy in problem-solving and show greater persistence when facing ambiguous or complex scenarios. This suggests that PBL promotes resilience, adaptability, and the confidence necessary to tackle challenges independently. Moreover, PBL encourages interdisciplinary thinking, which is increasingly vital in modern education. Complex societal problems rarely fall within a single disciplinary boundary. By integrating knowledge from science, technology, social studies, and the arts, students learn to identify interconnections, synthesize diverse perspectives, and apply holistic reasoning. For example, a PBL activity exploring environmental sustainability may require analysis of ecological data, policy

frameworks, and economic considerations. This multidimensional engagement fosters deeper critical evaluation skills and helps students appreciate the multifaceted nature of real-world problems. From a metacognitive standpoint, PBL develops students' ability to monitor their learning strategies and outcomes. When learners document the decision-making process, reflect on alternative solutions, and assess the effectiveness of their approaches, they reinforce skills in self-regulation and reflective judgment. This iterative process strengthens the ability to critique one's own assumptions and anticipate potential errors in reasoning—core aspects of critical thinking. Digital technologies further enhance the PBL environment by expanding access to authentic resources, collaborative tools, and simulation platforms. Platforms such as virtual laboratories, interactive modeling software, and collaborative research databases enable students to experiment, test hypotheses, and receive immediate feedback. Studies by Dochy et al. (2015) demonstrate that technology-supported PBL can significantly improve students' ability to evaluate evidence critically and integrate knowledge from multiple sources.

In conclusion, problem-based learning methods are an effective pedagogical strategy for developing critical thinking. PBL enables students to analyze knowledge independently, generate multiple solutions, and justify decisions. It simultaneously develops metacognitive, creative, social, and ethical skills, as well as collaborative and communication abilities. International research confirms PBL's effectiveness, making modern education interactive, practical, and motivational. Applying PBL strengthens students' critical thinking, independent learning, and prepares them for future professional activities. Overall, problem-based learning ensures intellectual and personal development, enhances educational quality, and prepares students to solve complex problems effectively. Problem-Based Learning represents a paradigm shift in education—one that prioritizes active inquiry, deep understanding, and reflective thinking. By engaging learners in authentic problem contexts, PBL fosters critical thinking skills essential for academic achievement and real-world problem solving. Through iterative cycles of questioning, research, collaboration, and reflection, students develop the cognitive agility to navigate complexity and uncertainty. As education continues to evolve in response to global demands, PBL remains a robust pedagogical strategy that cultivates not only knowledge but the critical capacity to use it wisely.

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