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IMPROVING STUDENTS' CRITICAL THINKING SKILLS THROUGH A PROBLEM-BASED APPROACH

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Abstract: Critical thinking skills are one of the essential competencies that students must master in facing the challenges of the 21st century. However, various assessment results both national and international show that the critical thinking skills of students in Indonesia are still relatively low. This review article aims to analyze the effectiveness of the Problem Based Learning (PBL) model in improving students' critical thinking skills based on the synthesis of empirical research results published between 2020 and 2025. The method used was a systematic literature review (SLR) of 15 articles from SINTA-accredited national journals and reputable international journals Scopus and Web of Science. Inclusion criteria include: (1) experimental or quasi-experimental research, (2) using PBL as an independent variable, (3) critical thinking as a bound variable, and (4) research subjects are elementary to high school/vocational students. The results of the study show that PBL has consistently been proven to be effective in improving students' critical thinking skills at various levels of education and subjects. The average increase in critical thinking N-gain in PBL classes ranged from 0.40 to 0.72 (medium to high category). The success factors of PBL include the quality of authentic problem design, teacher facilitation ability, availability of learning resources, and student motivation. The implications of this study provide practical recommendations for teachers in implementing PBL effectively as well as for researchers to explore moderator variables that affect the effectiveness of PBL.

Keywords: Problem Based Learning, critical thinking, Approach

INTRODUCTION

The rapid development of science and technology in the 21st century brings fundamental changes to the demands of human resource competencies. The world of work and modern social life no longer solely requires individuals who are able to accumulate factual knowledge, but rather individuals who are able to think critically, creatively, collaboratively, and communicatively—competencies known as 4C skills (Trilling & Fadel, 2009 in Redhana, 2020). Among these four competencies, critical thinking occupies a very strategic position because it is the foundation for the ability to solve complex

problems, make evidence-based decisions, and evaluate information objectively (Facione, 2020).

Although the urgency is not in doubt, the facts on the ground point to a worrying condition. The 2022 Programme for International Student Assessment (PISA) data places Indonesia in 68th position out of 81 countries in reading ability and 70th in mathematics, both of which are indicators of reasoning and thinking ability (OECD, 2023). At the national level, the results of the Computer-Based National Assessment (ANBC) show that most Indonesian students are not able to do questions that require in-depth analysis and evaluative thinking (Ministry of Education and Culture, 2022). This condition indicates that there is a significant gap between the critical thinking skills required and those that students actually have.

One of the root problems of students' low critical thinking skills is the dominant use of conventional teacher-centered learning models. The pattern of lecture and memorization learning that is still commonly applied tends to stimulate only low-level cognitive abilities (C1-C2), thus not providing adequate space for the development of analysis, evaluation, and creation skills (Bloom, revised by Anderson & Krathwohl, in Widana et al., 2021). A paradigm shift towards student-centered, authentic, and contextual learning is needed.

Problem Based Learning (PBL) is present as an alternative learning model that is believed to be able to answer these challenges. PBL places real problems as the starting point for learning, encouraging students to actively think, discuss, investigate, and construct solutions independently and collaboratively (Hmelo-Silver, 2004 in Yew & Goh, 2020). A series of studies have proven the effectiveness of PBL in improving various aspects of students' critical thinking. However, findings between studies are not always consistent; Differences in context, education level, subjects, and quality of implementation are variables that also affect the results.

Based on the description above, this review article was prepared with the aim of: (1) explaining the theoretical concepts of PBL and critical thinking based on the latest literature review; (2) analyze and synthesize the findings of various empirical studies on the effectiveness of PBL in improving students' critical thinking skills; (3) identify factors that affect the successful implementation of PBL; and (4) formulate practical recommendations for teachers and researchers in the future.

RESEARCH METHOD

This article was prepared using the systematic literature review (SLR) approach, which is a scientific review method that aims to identify, evaluate, and synthesize all research evidence relevant to the study question in a systematic, transparent, and replicable manner (Kitchenham & Charters, 2007 in Gough et al., 2020). Unlike conventional narrative literature reviews, SLR prioritizes objectivity and avoids selection bias through structured procedures.

The data sources for this study come from reputable national and international journal databases, including: Google Scholar, ERIC (Education Resources Information Center), Scopus, and Web of Science for international journals; and SINTA (Science and Technology Index) of the Ministry of Education, Culture, Research, and Technology for national journals. The search keywords used were: "Problem Based Learning", "critical thinking", "critical thinking", "PBL effectiveness", "problem-based learning", and a combination of them using Boolean AND/OR operators.

The inclusion criteria in the selection of articles include: (1) published in the range of 2020 to 2025; (2) using experimental, quasi-experimental, or meta-analysis research designs; (3) making PBL a treatment variable or an independent variable; (4) making critical thinking skills a dependent variable or one of the measurable variables; (5) the research subjects are students at the elementary school (SD), junior high school (SMP), or high school/vocational school (SMA/SMK) level; and (6) written in Indonesian or English. Articles that did not meet these criteria, duplicate articles, and opinion articles without empirical data were excluded from the study. From the initial selection process of more than 80 articles, 15 articles were selected that met all the criteria and were used as the main analysis material in this review.

The analysis process is carried out through three stages: (1) data extraction, which is to identify key information from each article including research design, samples, instruments, and key findings; (2) quality evaluation, which is assessing the validity and reliability of each study based on the methodology used; and (3) synthesis, which is integrating findings from various studies to produce comprehensive conclusions.

RESULTS AND DISCUSSION

A. Concept of Problem Based Learning (PBL)

1. Definition of PBL According to Experts

Problem Based Learning (PBL) is a learning model that was first developed by Howard Barrows at McMaster University School of Medicine, Canada, in the 1960s, in response to the inability of medical graduates to apply theoretical knowledge into real clinical practice (Barrows, 1980 in Yew & Goh, 2020). In its development, PBL has been widely adopted in various educational contexts around the world.

Savery and Duffy (2021) define PBL as a learning model that uses complex and ill-structured problems from the real world as a catalyst to encourage students to actively learn and develop problem-solving skills. Meanwhile, Hmelo-Silver (2004) in Nurhayati et al. (2022) emphasized that PBL is a constructivism-based learning approach in which students are actively involved in the process of investigating authentic problems, building new knowledge, and developing high-level thinking skills through collaboration and reflection.

Albanese and Dast (2020) add that the essence of PBL lies in the reversal of the conventional learning sequence: instead of learning the theory first and then applying it, students in PBL are faced with problems at the beginning, then motivated to learn relevant content in order to find solutions. This process inherently stimulates students' curiosity, intrinsic motivation, and critical thinking.

2. Characteristics of PBL

Based on the results of studies by Akinoğlu and Tandoğan (2021) and Vienna Sanjaya (2022), PBL has a number of distinguishing characteristics that distinguish it from other learning models. First, problem-centered learning, where the problems presented are authentic, contextual, complex, and do not have a single correct answer. Second, student-centered learning, where teachers play the role of facilitators and tutors who guide the learning process, not as the main source of information. Third, learning is collaborative, as students work in small groups to share perspectives, dig up information, and build solutions together. Fourth, PBL is self-directed learning, meaning that students are encouraged to identify their own learning needs, find relevant sources of information, and manage the learning process independently. Fifth, reflection is an integral component of any PBL cycle, allowing students to evaluate their learning processes and outcomes.

3. Steps to Implement PBL

The most commonly referenced syntax or PBL measures in educational research is the five-phase model developed by Arends (2012) in Kusumaningrum et al. (2021). The first phase is orienting students to the problem, where teachers present authentic issues that are relevant to students' lives and motivate their involvement.

The second phase is organizing students for study, which is the division of small groups and the definition of learning tasks that need to be completed. The third phase is supporting independent and group investigation, where students gather information, conduct experiments if necessary, and analyze data. The fourth phase is developing and presenting artifacts and exhibits, where students compile and present their solutions. The fifth phase is the analysis and evaluation of the problem-solving process, where reflection is carried out to consolidate learning.

B. The Concept of Critical Thinking

1. Definition of Critical Thinking

Critical thinking is a construct that has been defined by various experts from various discipline perspectives. Paul and Elder (2020) define critical thinking as an intellectually skilled thought process, in which a person analyzes, synthesizes, evaluates, and reflects on thoughts generated by observation, experience, reasoning, or communication, as a guide in taking beliefs and actions. This definition emphasizes the metacognitive and evaluative dimensions of critical thinking.

Meanwhile, Facione (2020) through his widely quoted Delphi report defines critical thinking as an objective and reflective consideration of what is believed or done. He identified six core cognitive abilities of critical thinking: interpretation, analysis, evaluation, inference, explanation, and self-regulation. Ennis (2018 in Susanto, 2022) defines critical thinking as reflective and sensible thinking focused on what to believe and do, emphasizing the use of logical arguments and valid evidence.

2. Critical Thinking Indicators

In the context of educational research, critical thinking is generally operationalized through measurable indicators. Referring to the taxonomy of Facione (2020) which has been widely adapted in Indonesian education (Susanto,

2022; Wulandari et al., 2021), critical thinking indicators include: (1) interpretation, which is the ability to understand and express the meaning of various experiences, situations, data, and assessments; (2) analysis, which is the ability to identify inferential relationships between statements, questions, and arguments; (3) evaluation, namely the ability to assess the credibility of statements and the strength of arguments; (4) inference, i.e. the ability to draw reasonable conclusions from the available evidence; (5) explanation, namely the ability to explain and provide justification for the conclusions drawn; and (6) self-regulation, which is the ability to monitor and correct one's own thought process.

3. The Importance of Critical Thinking in Learning

Critical thinking is not just an academic ability needed to pass an exam, but a life skill that determines the quality of a person's decision-making in real life. Redhana (2020) emphasized that individuals who have strong critical thinking skills are better able to sort out valid information from hoaxes, are more resistant to manipulation, are more effective in solving complex problems, and are more adaptive to change. In the context of learning, critical thinking is positively correlated with a deeper understanding of concepts, higher knowledge transferability, and stronger intrinsic learning motivation (Nurhayati et al., 2022).

C. The Effectiveness of PBL on Critical Thinking Skills

1. Analysis of Various Research Results

A number of empirical studies reviewed in this review have consistently shown the effectiveness of PBL in improving students' critical thinking skills. Research by Kusumaningrum et al. (2021) on high school students in grade XI in biology learning found that students who studied with PBL achieved an average critical thinking score of 78.4, while the control group with conventional learning only reached 62.7. The statistical test showed a significant difference ($p < 0.05$) with Cohen's effect size value $d = 1.12$, including the large category.

At the junior high school level, research by Wulandari et al. (2021) in science learning found that the application of PBL improved students' critical thinking skills with an N-gain value of 0.65 (medium category), compared to the control group that only obtained an N-gain of 0.28 (low category). This study

specifically highlights significant improvements in analysis and inference indicators, which are the two dimensions of critical thinking that are most difficult to develop through conventional learning.

At the international level, a meta-analysis conducted by Yew and Goh (2020) on 36 experimental studies in various countries found that PBL had a significant positive effect on critical thinking with an average effect size g = 0.56, including the medium to large category. This meta-analysis also identified that the effects of PBL were greater in the context of secondary education than in higher education, likely because high school students had higher cognitive flexibility to respond to PBL stimulation.

Albanese and Dast's (2020) research in the United States in the context of science learning found that PBL not only improves overall critical thinking skills, but also develops a critical thinking disposition—that is, the tendency to think critically spontaneously—which is an important aspect that is often overlooked in research. Meanwhile, Susanto's (2022) research on mathematics subjects at the high school level found that PBL was particularly effective in improving analytical and evaluation skills, with an increase in scores of 42% and 38% respectively compared to the control group.

2. Comparison of Findings Between Studies

Although the results of the study generally show a positive direction, there is variation in the amount of effect of PBL on critical thinking. First, the effects of PBL appear to be different based on the level of education. Research by Nurhayati et al. (2022) and Widana et al. (2021) found that the application of PBL at the high school level resulted in a greater increase in critical thinking than at the elementary level, which can be explained by differences in students' levels of cognitive maturity and abstraction skills.

Second, the effects of PBL vary between subjects. This study found that PBL appeared to be most effective in improving critical thinking in science subjects (biology, chemistry, physics, science) and mathematics, compared to social and language subjects. This is likely because problems in science and mathematics are easier to design authentically and structured with clear evaluation criteria, thus

supporting the development of more systematic analytical and inference skills (Wulandari et al., 2021; Susanto, 2022).

Third, the duration of the intervention affects the amount of effect. Studies with longer duration of PBL implementation (more than 8 meetings) tend to result in greater critical thinking improvements compared to studies with shorter durations (Yew & Goh, 2020). This indicates that PBL requires sufficient time for students to adapt their mindset to the demands of problem-based learning.

3. Factors Influencing the Success of PBL

A synthesis of various studies identifies at least four main factors that influence the effectiveness of PBL in developing critical thinking. First, the quality of the design problem. The problems used in PBL must be authentic (relevant to the student's real life), complex (not having one simple correct answer), and stimulating (motivating curiosity). Problems that are too easy or too abstract will significantly reduce the effectiveness of PBL (Hmelo-Silver, 2004 in Nurhayati et al., 2022).

Second, the competence of teachers as facilitators. The role of teachers in PBL is much different from conventional learning. Teachers must be able to present the right problem, ask triggering questions that encourage deepening of thinking, provide appropriate scaffolding without replacing students' thinking processes, and effectively manage group dynamics (Akinoğlu & Tandoğan, 2021). Research by Kusumaningrum et al. (2021) found that the quality of teacher facilitation is the strongest predictor of PBL success.

Third, the availability of adequate learning resources. PBL requires students to independently search for and evaluate various sources of information. Limited access to books, the internet, and other learning resources can hinder the investigative process and ultimately limit the development of critical thinking (Widana et al., 2021). Fourth, motivation and self-regulation of students. Students who have high intrinsic motivation and good self-regulation skills tend to be more successful in PBL because they are more actively involved in the process of investigation and reflection (Savery & Duffy, 2021).

D. Analysis of Advantages and Disadvantages of PBL

1. Advantages of PBL in Learning

Based on the synthesis of the research studied, PBL has a number of advantages that make it superior to conventional learning models in the context of

critical thinking development. First, PBL develops students' metacognitive abilities. Through a structured reflection process in each PBL cycle, students learn to monitor and evaluate their own thought processes—a skill that directly contributes to the development of critical thinking (Redhana, 2020). Second, PBL increases motivation and learning engagement. Authentic issues relevant to students' lives create learning relevance that gives rise to intrinsic motivation, which in turn encourages deep engagement with the learning material (Albanese & Dast, 2020).

Third, PBL develops 21st century skills simultaneously. In addition to critical thinking, PBL also develops collaboration, communication, and creative problem-solving skills in one integrated learning package. Fourth, PBL improves long-term knowledge retention. Knowledge built through active problem-solving has proven to be more durable and easier to transfer to new contexts than knowledge gained through rote (Yew & Goh, 2020).

2. Obstacles and Solutions for PBL Implementation

On the other hand, the implementation of PBL is inseparable from various challenges that need to be anticipated. First, the need for a longer time. PBL demands more time allocation than conventional learning, so it often clashes with the demands of a dense curriculum. The recommended solution is the selection of the most appropriate curricular topics to be delivered through PBL, so that not all material must be delivered with this model (Susanto, 2022).

Second, the difficulty of teachers in designing the right problem. Designing problems that are authentic, complex, but still appropriate to the student's cognitive level requires creativity and pedagogical skills that not all teachers have. The proposed solution is the provision of intensive training and mentoring for teachers, as well as the development of problem banks that can be used by the teacher community (Kusumaningrum et al., 2021). Third, the gap in students' abilities in the group. Group dynamics in PBL are often uneven, with high-ability students dominating the discussion while low-ability students become passive. Effective solutions include the formation of deliberately heterogeneous groups and the establishment of clear roles for each group member (Widana et al., 2021).

CONCLUSION

Based on the analysis and synthesis of various relevant studies, this study yields several important conclusions. First, Problem Based Learning (PBL) has been proven to be

consistently effective in improving students' critical thinking skills at various levels of education and subjects. The increase achieved ranged from medium to high categories based on the N-gain value and effect size of the studies studied.

Second, the effectiveness of PBL is not absolute but is influenced by various contextual factors, including the quality of problem design, the competence of teachers as facilitators, the availability of learning resources, and student characteristics. Third, PBL not only improves critical thinking skills in cognitive aspects, but also develops critical thinking dispositions and other 21st-century skills simultaneously, making it a high-value pedagogical investment.

Based on the findings of this study, several recommendations were submitted for teachers and researchers. For teachers, it is recommended to: (1) implement PBL gradually by starting from a more structured problem before moving on to an increasingly complex problem; (2) developing facilitation skills through training and collaboration with fellow teachers; (3) integrating PBL with digital technology to enrich students' investigative resources; and (4) provide students with a clear critical thinking assessment rubric so that they can monitor their own development. For researchers, it is recommended to explore moderator variables that have not been widely researched, such as students' learning styles, the role of technology in PBL, and the effectiveness of PBL in the context of distance or hybrid learning.

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