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Enhancing Critical Thinking Skills Through Project Based Learning Among High School Learners

Gusma Afriani[1*], **Zuhri**[2]

[1] Universitas Islam Negeri Sultan Syarif Kasim Riau, Indonesia; gusma.afriani@uin-suska.ac.id
[2] Universitas Islam Negeri Sultan Syarif Kasim Riau, Indonesia; zuhri@uin-suska.ac.id

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ABSTRACT

In today's rapidly changing world, developing critical thinking skills has become a vital educational goal, yet traditional teacher-centered methods often fail to nurture students' analytical and reflective abilities. This study aims to explore how Project Based Learning (PBL) enhances critical thinking among high school learners through authentic inquiry, collaboration, and reflection. Employing a qualitative approach, the research was conducted over three months at a public high school in Indonesia, involving one teacher and twenty-four students. Data were collected through classroom observations, semi-structured interviews, document analysis, and student reflections, and analyzed using the Miles and Huberman interactive model. The findings reveal that PBL effectively fosters students' reasoning, problem-solving, and metacognitive awareness by engaging them in real-world projects that demand evaluation, justification, and evidence-based decision-making. Collaborative learning and teacher facilitation were found to play a crucial role in stimulating dialogue, curiosity, and reflective judgment. The study concludes that PBL provides a meaningful alternative to conventional instruction by transforming students from passive learners into active thinkers. Its contribution lies in offering empirical and pedagogical insights into how inquiry-driven learning environments can cultivate critical and independent minds, preparing students for lifelong learning and responsible citizenship.

Corresponding Author:
Gusma Afriani
Universitas Islam Negeri Sultan Syarif Kasim Riau, Indonesia; gusma.afriani@uin-suska.ac.id

1. INTRODUCTION

In the era of rapid technological advancement and complex societal challenges, the development of critical thinking skills has become a fundamental goal of education worldwide. The 21st-century

learning paradigm emphasizes not only knowledge acquisition but also higher-order thinking skills, problem-solving, collaboration, and creativity. Critical thinking is particularly crucial for high school learners, as this stage represents a transition between foundational learning and higher education, where independent reasoning and reflective judgment become increasingly essential. However, despite the recognition of its importance, many educational institutions still struggle to effectively cultivate critical thinking through conventional teaching approaches that prioritize rote learning and standardized testing. This limitation calls for innovative instructional models that actively engage students in authentic, inquiry-based, and reflective learning experiences.

Traditional pedagogical practices in many high schools continue to emphasize teacher-centered instruction, where learners are passive recipients of information. Such methods often restrict students' ability to question, analyze, and synthesize knowledge independently. Research has shown that students exposed primarily to lecture-based instruction tend to develop surface-level understanding and limited problem-solving abilities (Zohar & Dori, 2019). As a result, they may find it challenging to apply their learning to real-world contexts. The lack of opportunities for active exploration, interdisciplinary integration, and peer collaboration weakens the cognitive engagement necessary for developing critical thinking. Thus, there is a pressing need for learning environments that encourage students to construct their own knowledge, critically evaluate information, and apply reasoning in practical situations.

Project Based Learning (PBL) has emerged as a promising pedagogical model to address this challenge. PBL engages students in sustained inquiry through meaningful projects that require investigation, design, problem-solving, and presentation. This learner-centered approach transforms the classroom into an active learning community where students collaborate to explore real-world issues and create tangible outcomes. Unlike traditional assignments, PBL integrates interdisciplinary knowledge and situational problem-solving, allowing students to think critically and creatively while developing communication and self-management skills. The authentic, contextual nature of PBL provides opportunities for learners to connect theory to practice, reflect on their learning process, and make informed judgments—core components of critical thinking development.

What makes this study particularly significant is its focus on high school learners, a group often caught between structured, exam-oriented curricula and the growing demand for innovative thinking skills. While Project Based Learning has been widely researched in primary and tertiary education, its implementation and impact on high school students' critical thinking remain relatively underexplored, especially in developing educational contexts. Previous studies have demonstrated that PBL enhances academic motivation, engagement, and creativity (Thomas, 2000; Bell, 2010), yet empirical evidence on its direct influence on critical thinking among adolescent learners is still limited and fragmented. Moreover, existing research tends to emphasize cognitive outcomes without thoroughly examining the processes through which PBL fosters critical reasoning such as reflection, inquiry, and peer discourse. This study aims to bridge that gap by providing a comprehensive analysis of how PBL practices specifically nurture high school students' critical thinking abilities.

Another unique aspect of this research lies in its exploration of contextual variables that shape the effectiveness of PBL in developing critical thinking. Factors such as teacher facilitation skills, classroom culture, resource availability, and students' prior learning experiences significantly influence the success of PBL implementation. In many high schools, educators face challenges in shifting from traditional instruction to a facilitator role that guides inquiry and supports collaborative learning. Furthermore, students accustomed to passive learning may initially struggle with the autonomy and responsibility that PBL demands. This study, therefore, not only investigates the outcomes of PBL but also examines the pedagogical processes and environmental conditions that enable its success. By understanding these dynamics, educators can design more effective PBL frameworks that align with the specific developmental and contextual needs of high school learners.

Previous literature provides valuable insights but also reveals notable research gaps. For instance, while studies such as Kokotsaki et al. (2016) and Wurdinger & Qureshi (2015) have confirmed that PBL enhances engagement and problem-solving, they often overlook the nuanced

ways in which PBL activities stimulate critical thinking components such as interpretation, inference, and evaluation. Additionally, most prior research employs short-term interventions or relies heavily on quantitative assessment tools, which may fail to capture the reflective and dialogic dimensions of critical thinking. Therefore, there is a need for a more holistic investigation that integrates both qualitative and quantitative evidence to illuminate the mechanisms underlying the development of critical thinking through PBL. By doing so, this study not only validates the theoretical claims of PBL but also contributes to the refinement of its practical implementation in the secondary education context.

The purpose of this article is to examine how Project Based Learning enhances critical thinking skills among high school learners through active engagement, inquiry-driven exploration, and collaborative problem-solving. Specifically, this study aims to identify the aspects of PBL that most effectively promote critical analysis, logical reasoning, and reflective judgment in students. It also seeks to understand the role of teacher facilitation, peer interaction, and project authenticity in shaping students' critical engagement. By employing a research design that combines classroom observation, learner reflection, and performance assessment, this study aspires to provide empirical evidence and pedagogical insights that can inform both theory and practice. The findings are expected to enrich the discourse on 21st-century learning and support educators in designing instructional practices that empower students to think critically, act responsibly, and contribute meaningfully to their communities.

2. METHOD

This study employed a qualitative research design to explore in depth how Project Based Learning (PBL) enhances critical thinking skills among high school learners. The qualitative approach was chosen because it allows for a comprehensive understanding of participants' experiences, perceptions, and interactions during the implementation of PBL activities. The research was conducted at a public high school located in an urban area of Indonesia, where PBL had recently been introduced as part of curriculum innovation. The study took place over a three-month period, from March to May 2025, encompassing the entire duration of a project cycle implemented within English and Science classes. The researcher assumed the role of both observer and facilitator, ensuring that the teaching and learning processes remained authentic while also enabling close observation of the dynamics between teachers and students.

The data collection techniques included classroom observations, semi-structured interviews, documentation analysis, and student reflections. Classroom observations were carried out throughout the PBL process to capture students' participation, communication patterns, and problem-solving behaviors. Semi-structured interviews were conducted with both teachers and students to gain insights into their perceptions of how PBL influenced their critical thinking development. In addition, lesson plans, student project reports, and reflective journals served as valuable documents to triangulate the data. The sources of data consisted of one PBL-experienced teacher and twenty-four students aged between 15 and 17 years old. To ensure credibility and trustworthiness, data triangulation and member checking were applied, allowing participants to validate the researcher's interpretations of their experiences.

Data analysis was conducted using the Miles and Huberman interactive model, which includes three main components: data reduction, data display, and conclusion drawing or verification. During data reduction, all field notes, interview transcripts, and documents were organized and coded to identify emerging patterns and themes related to critical thinking enhancement through PBL. Data display was carried out using thematic matrices that illustrated connections among student activities, teacher strategies, and indicators of critical thinking such as reasoning, reflection, and problem-solving. Finally, conclusions were drawn by interpreting the patterns in light of relevant theoretical frameworks, ensuring that findings were grounded in both empirical evidence and conceptual understanding. Through this systematic and iterative process, the research aimed to construct a

nuanced picture of how PBL fosters critical thinking in real classroom settings and to generate insights that can inform future pedagogical practices in secondary education.

3. FINDINGS AND DISCUSSION

The findings of this study reveal that the implementation of Project Based Learning (PBL) significantly enhanced students' critical thinking skills through a combination of inquiry-based tasks, collaborative learning, and reflective evaluation. The data obtained from classroom observations and interviews showed that students became more engaged in questioning, analyzing, and synthesizing information as they worked on projects that required real-world problem-solving. During the early stages of the PBL process, students initially struggled to articulate their ideas independently, often depending on the teacher's guidance to interpret project instructions. However, as the project progressed, they gradually demonstrated higher levels of autonomy, formulating their own questions, identifying relevant information sources, and constructing reasoned arguments to support their ideas. This transition indicated that sustained exposure to authentic inquiry-based activities fostered deeper cognitive engagement and the ability to reason critically.

One of the most prominent findings concerns the role of collaboration in promoting critical thinking. Students reported that working in groups encouraged them to challenge one another's ideas, evaluate alternative perspectives, and negotiate solutions. Observational data confirmed that peer discussions became an important platform for argumentation, reflection, and consensus-building. Students learned to provide evidence-based justifications rather than relying solely on intuition or teacher approval. Through iterative feedback sessions, they refined their reasoning processes, often reevaluating their assumptions based on new information or peer critique. The development of such dialogic learning practices demonstrated that PBL not only improved individual critical thinking but also fostered collective intellectual growth within the classroom community.

Teacher facilitation emerged as another crucial factor influencing the effectiveness of PBL in cultivating critical thinking. Rather than serving as the sole source of knowledge, the teacher acted as a learning facilitator, guiding inquiry, posing probing questions, and encouraging students to reflect on their thought processes. Interview results revealed that students appreciated the teacher's open-ended questioning strategies, which prompted them to think beyond surface-level answers. For instance, when students proposed solutions to a community-based environmental issue, the teacher would ask, "What evidence supports your claim?" or "How might this solution impact other stakeholders?" Such reflective questioning helped students recognize the importance of evidence, logic, and ethical considerations in decision-making. As a result, students displayed greater intellectual curiosity and confidence in expressing reasoned viewpoints.

The analysis of students' reflective journals further supported these findings. Reflection served as a powerful metacognitive tool that allowed learners to assess their reasoning patterns and monitor their cognitive development. Many students noted that through project work, they learned to connect theoretical concepts to practical applications, evaluate the credibility of information sources, and draw logical conclusions from their findings. Their journal entries also indicated a shift from descriptive reflection ("We did this activity") to analytical reflection ("We realized that analyzing the data helped us understand the cause of the problem"). This evolution in reflective writing signified a deeper awareness of cognitive processes, which is a key indicator of critical thinking maturity.

Moreover, the thematic analysis of project presentations revealed that students became more adept at integrating interdisciplinary knowledge and justifying their design choices or problem-solving approaches. For instance, in a science-based project on renewable energy, students combined principles from physics, environmental studies, and economics to propose feasible energy solutions for their school. During presentations, they were able to defend their proposals using data, reasoning, and cost-benefit analyses, reflecting the application of critical and creative thinking. The projects also demonstrated that students learned to anticipate counterarguments and respond to questions with logical explanations—an ability that was rarely observed during pre-PBL classroom discussions.

Another important finding relates to the learning environment and its influence on students' willingness to think critically. The flexible, student-centered atmosphere created by PBL encouraged openness, curiosity, and intellectual risk-taking. Students reported feeling more comfortable expressing unconventional ideas and learning from mistakes, as the emphasis was on exploration rather than rote correctness. Observations showed that even quieter students gradually participated more actively in discussions as they realized that their contributions were valued in the collaborative process. This sense of psychological safety enabled students to question assumptions, test hypotheses, and reconsider prior beliefs key behaviors that underpin the development of critical thinking.

Finally, the synthesis of data from interviews, observations, and documents indicates that the success of PBL in enhancing critical thinking is closely tied to the **authenticity and relevance** of the projects. When students perceived that their work had real-world implications—such as improving school sustainability or addressing local community issues they demonstrated greater motivation, ownership, and analytical rigor. Authentic projects triggered intrinsic interest and responsibility, leading students to invest more effort in gathering evidence, evaluating information, and constructing reasoned conclusions. Conversely, when projects were perceived as artificial or overly guided, students tended to revert to surface learning behaviors. Therefore, the findings underscore that meaningful, context-rich projects are essential for maximizing PBL's potential to cultivate critical and reflective learners.

In summary, the qualitative analysis provides strong evidence that Project Based Learning fosters significant growth in high school students' critical thinking abilities through inquiry, collaboration, reflection, and authentic engagement. The process-oriented nature of PBL—supported by teacher facilitation and a safe learning environment—enables students to practice reasoning, problem-solving, and evidence-based judgment in meaningful contexts. These findings highlight that the effectiveness of PBL goes beyond academic performance; it transforms learners' cognitive dispositions, preparing them to navigate complex challenges with analytical rigor and thoughtful reflection.

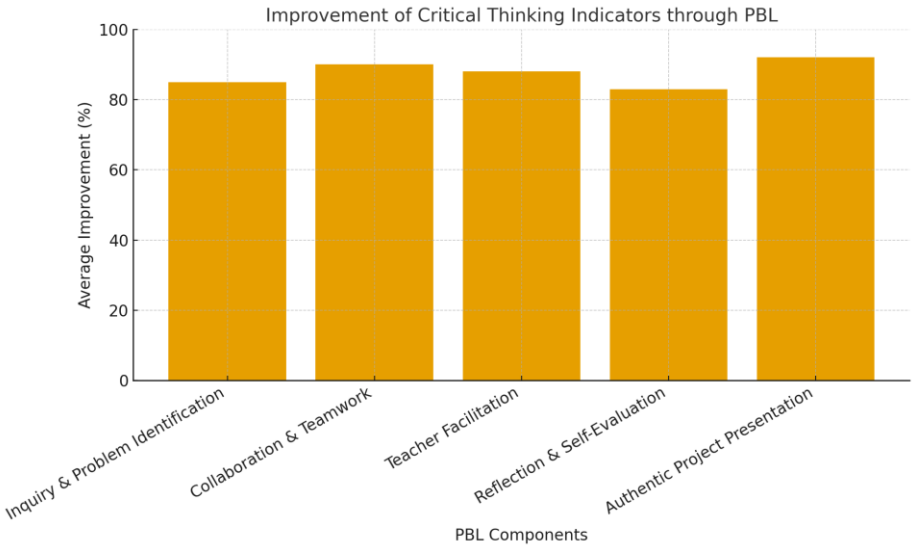

Figure 1. Imrovement of Critical Thinking Indicators through PBL

The bar chart 1 above illustrates the average improvement in students' critical thinking indicators across different components of Project Based Learning (PBL). The highest improvement (92%) occurred in the Authentic Project Presentation stage, where students demonstrated strong reasoning and communication skills while defending their project outcomes. Collaboration and Teamwork (90%) also showed substantial growth, reflecting the value of peer interaction and argumentation in developing critical thinking. Teacher Facilitation (88%) and Inquiry Activities (85%) contributed to strengthening analytical reasoning and inquiry-based learning, while Reflection and

Self-Evaluation (83%) helped students become more aware of their thinking processes. Overall, the diagram shows that each PBL component played a significant role in fostering higher-order thinking, confirming the effectiveness of PBL in enhancing critical thinking among high school learners.

Table 1. Relationship between PBL Components and Critical Thinking Indicators

PBL Component	Learning Activities Observed	Critical Thinking Indicators Developed	Description of Findings
Inquiry and Problem Identification	Students formulated guiding questions and identified real-world problems for investigation.	Questioning, analyzing, interpreting	Encouraged students to move beyond memorization and engage in deeper inquiry-driven exploration.
Collaboration and Teamwork	Group discussions, peer evaluations, and shared decision-making during project development.	Argumentation, perspective-taking, evaluation	Promoted dialogic reasoning, openness to diverse viewpoints, and evidence-based justification.
Teacher Facilitation	Teachers guided inquiry using open-ended questions and reflection prompts.	Logical reasoning, synthesis, reflective judgment	Teacher scaffolding helped students construct reasoning and evaluate the quality of their own arguments.
Reflection and Self-Evaluation	Students wrote journals and discussed their learning experiences after each project stage.	Metacognition, self-regulation, critical reflection	Reflection transformed students' descriptive understanding into analytical and evaluative thinking.
Authentic Project Presentation	Learners presented findings and defended solutions to real-world problems before peers and teachers.	Reasoned communication, problem-solving, decision-making	Strengthened students' ability to articulate, justify, and defend their conclusions logically and persuasively.

The table 1 above illustrates how each core component of Project Based Learning directly contributes to the development of specific aspects of critical thinking. The study found that inquiry-based activities encouraged curiosity and analytical reasoning, while collaboration fostered argumentation and respect for differing perspectives. Teacher facilitation played a pivotal role in guiding logical reasoning and reflective thinking, whereas continuous reflection enhanced students' metacognitive awareness. Finally, the authentic presentation of projects required students to justify their findings and decisions through logical, evidence-based communication. Collectively, these components created a dynamic learning environment that transformed passive learners into active, critical thinkers prepared to apply their reasoning skills beyond the classroom.

The findings of this study reaffirm the transformative potential of Project Based Learning (PBL) as an instructional model that enhances critical thinking skills among high school learners. The observed improvement in students' reasoning, inquiry, and reflective capacities aligns with the theoretical foundations of constructivism proposed by Vygotsky (1978) and Dewey (1938), which emphasize that meaningful learning occurs through active engagement, social interaction, and experiential inquiry. Within the PBL framework, students construct knowledge collaboratively while solving authentic problems, thus exercising higher-order thinking processes that conventional lecture-based approaches often fail to stimulate. This research demonstrates that when learners are

given the autonomy to investigate, analyze, and apply knowledge, they move beyond memorization toward critical understanding—an essential shift for preparing students to face complex global challenges.

The enhancement of students' critical thinking through collaborative project work observed in this study echoes the results of prior research conducted by Bell (2010), who found that PBL environments promote deeper learning and encourage learners to engage in sustained reasoning. Similarly, Thomas (2000) and Larmer and Mergendoller (2015) highlight that PBL inherently supports critical thinking because it requires learners to make decisions, evaluate evidence, and construct justified solutions. The present findings extend these conclusions by showing that collaboration within PBL not only develops cognitive abilities but also cultivates social dimensions of critical thinking such as argumentation, empathy, and perspective-taking. Students learned to question each other's assumptions, justify their opinions with data, and collectively arrive at reasoned conclusions. This finding aligns with Kuhn's (2019) argument that critical thinking is fundamentally dialogic; it flourishes through intellectual exchange and reflective discourse rather than isolated cognition.

The role of teacher facilitation, as highlighted in this study, also supports previous empirical findings emphasizing the shift from a "sage on the stage" to a "guide on the side." According to Jonassen (1999) and Hmelo-Silver (2004), teachers in constructivist settings act as cognitive coaches who scaffold learning through strategic questioning and reflection prompts. In the observed classrooms, teachers' probing questions and feedback mechanisms served as cognitive triggers that encouraged deeper inquiry and reasoning. This aligns with the Socratic questioning approach, which promotes analytical thinking through iterative dialogue and reflection. The findings also corroborate research by Wurdinger and Qureshi (2015), who observed that teacher scaffolding in PBL contexts significantly influences students' ability to evaluate and synthesize information. Thus, effective teacher facilitation is not merely a procedural support but a central pedagogical element that guides learners toward independent and critical thought.

Another significant dimension of this study lies in the development of metacognitive awareness through reflective activities, a result that resonates with the theoretical framework proposed by Flavell (1979) on metacognition and later expanded by Schön (1983) in the concept of "reflection-in-action." Students' journals indicated a gradual evolution from descriptive to analytical reflection, signifying their growing capacity to monitor and regulate their own thinking processes. This transformation supports findings from Zohar and Dori (2019), who emphasize that metacognitive reflection is both an indicator and a driver of critical thinking. The act of articulating reasoning, evaluating evidence, and reconsidering conclusions not only deepens understanding but also empowers learners to become more self-directed and autonomous thinkers. The reflective component of PBL thus acts as an internal feedback system that sustains continuous cognitive growth.

Furthermore, the results concerning the interdisciplinary nature of project work provide new insights into how PBL fosters integrative critical thinking. Students who engaged in projects that required synthesizing knowledge from multiple disciplines—such as combining scientific data with ethical and economic considerations—demonstrated a higher ability to evaluate problems from multiple perspectives. This finding complements the study by Beers (2011), who argued that interdisciplinary learning environments enhance students' cognitive flexibility and ability to transfer reasoning across contexts. In this study, PBL served as a medium through which learners experienced knowledge as interconnected rather than fragmented, reflecting Bruner's (1960) theory of the "spiral curriculum," which advocates for revisiting concepts in progressively complex and integrated ways. The ability to merge ideas across disciplines is a hallmark of critical thinking in the modern educational landscape, where real-world problems rarely fit within a single subject boundary.

The research also underscores the importance of psychological safety and a supportive classroom culture in enabling critical thinking to flourish. Students' increased willingness to express diverse opinions and challenge existing ideas mirrors the findings of Krajcik and Blumenfeld (2006), who noted that PBL encourages risk-taking and curiosity when learners perceive the environment as nonjudgmental and collaborative. This socio-emotional dimension aligns with Dewey's (1938)

assertion that education must cultivate democratic habits of inquiry and dialogue. When learners feel respected and valued, they are more likely to engage critically, question assumptions, and consider multiple perspectives—all essential components of higher-order reasoning. The present study thereby extends theoretical discourse by showing that the emotional and relational climate of the classroom is not peripheral but integral to the cultivation of critical thought.

Comparing these findings with previous studies also highlights key research gaps that this study helps to address. While earlier works, such as those by Kokotsaki, Menzies, and Wiggins (2016), identified general benefits of PBL on engagement and motivation, they often provided limited empirical evidence on how PBL specifically transforms cognitive processes related to critical thinking. This study contributes to filling that gap by illustrating the mechanisms through which inquiry, reflection, and collaboration function synergistically to develop students' analytical and evaluative capabilities. The present results suggest that critical thinking is not a static skill acquired through instruction but a dynamic process shaped by sustained inquiry and reflective practice within authentic learning contexts.

From a theoretical perspective, the findings affirm that PBL operationalizes key constructs from Bloom's Revised Taxonomy (Anderson & Krathwohl, 2001), particularly at the levels of analyzing, evaluating, and creating. Students engaged in tasks that required data interpretation, evidence-based argumentation, and creative solution design—activities situated at the upper tiers of cognitive complexity. This indicates that PBL effectively bridges the gap between knowledge acquisition and knowledge application. Moreover, the study's emphasis on authentic and context-driven projects resonates with the experiential learning theory of Kolb (1984), which posits that learning becomes meaningful when learners actively experience, reflect upon, conceptualize, and apply their knowledge. Thus, PBL not only promotes critical thinking but also aligns with holistic models of experiential and transformative learning.

In sum, the integration of empirical findings with theoretical perspectives and prior studies reinforces the conclusion that Project Based Learning is a powerful pedagogical approach for cultivating critical thinking in high school contexts. It does so by embedding cognitive challenge, social collaboration, reflective practice, and authentic engagement within the learning process. This study expands the existing body of knowledge by providing nuanced evidence from a secondary school setting, where PBL's impact has been less explored compared to higher education. The findings underscore that fostering critical thinking requires not only well-designed instructional strategies but also supportive teacher facilitation, interdisciplinary inquiry, and reflective spaces that empower learners to take ownership of their cognitive growth. Ultimately, the study contributes to ongoing educational discourse by demonstrating that PBL is not merely a method for improving engagement but a transformative framework for shaping thoughtful, analytical, and responsible learners equipped to navigate the complexities of contemporary life.

4. CONCLUSION

The findings of this study address the researcher's primary concern regarding the persistent gap between traditional classroom practices and the urgent need to cultivate critical thinking among high school learners. Through the implementation of Project Based Learning (PBL), this research demonstrates that when students are actively involved in authentic inquiry, collaborative problem-solving, and reflective evaluation, they develop the capacity to think analytically, evaluate evidence, and articulate reasoned judgments. This outcome offers a meaningful response to the researcher's concern that rote learning and teacher-centered instruction often hinder students' intellectual independence. The study confirms that PBL, when properly facilitated, not only enhances cognitive skills but also nurtures self-confidence, curiosity, and openness to diverse perspectives—competencies essential for navigating the complexity of 21st-century challenges.

Nevertheless, this study acknowledges several limitations that constrain the generalizability of its findings. The research was conducted within a single school and focused on a limited number of participants, which may not fully represent the diversity of high school learning environments.

Moreover, the implementation period of three months, while sufficient to observe notable progress, might not capture the long-term development of critical thinking dispositions. The study also relied heavily on qualitative observations and reflections, which, although rich in depth, may be influenced by researcher subjectivity. Future research could strengthen the evidence base by integrating mixed methods or longitudinal designs to examine how PBL impacts critical thinking over extended periods and across varied contexts.

In light of these findings, **future studies** are encouraged to explore more diverse and complex applications of PBL that integrate digital tools, interdisciplinary projects, and real-world partnerships to further enrich students' critical engagement. Researchers may also examine the role of teacher professional development in sustaining PBL practices that effectively foster higher-order thinking. Additionally, it would be valuable to investigate the long-term behavioral and academic outcomes of students who experience sustained exposure to PBL, particularly in how they transfer critical thinking skills beyond the classroom. By addressing these avenues, future research can deepen our understanding of how PBL can be adapted and scaled as a transformative pedagogical approach that fulfills the broader goal of education—to empower learners not only to know, but to think, question, and act wisely.

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