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Integrating Problem-Based Learning to Develop Critical Thinking Competencies in Secondary Education

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Abstract

This qualitative study investigates the integration of Problem-Based Learning (PBL) as a pedagogical approach to develop critical thinking competencies among secondary education students. The research examines how PBL methodologies can be effectively implemented to enhance students' higher-order thinking skills within the Indonesian educational context. Through a comprehensive analysis of classroom observations, in-depth interviews with educators, and document analysis, this study identifies key implementation strategies, challenges, and outcomes of PBL integration. The findings reveal that PBL significantly improves students' analytical reasoning, problem-solving abilities, and metacognitive skills when systematically incorporated into the curriculum. Furthermore, the research highlights the importance of teacher preparation, supportive learning environments, and authentic assessment methods in maximizing the effectiveness of PBL for critical thinking development. This study contributes to the growing body of knowledge on innovative pedagogical approaches in secondary education and provides practical recommendations for educators and policymakers seeking to foster critical thinking competencies essential for 21st-century learners.

Keywords*: *development, learning model, illustrated paper, ability, language

I. INTRODUCTION

The 21st century is characterized by rapid technological advancement, global interconnectedness, and an ever-increasing complexity of societal challenges. In this context, education systems worldwide are under mounting pressure to equip students with not only foundational knowledge but also higher-order thinking skills that enable them to navigate uncertainty, solve complex problems, and participate actively in civic life. Among these skills, critical thinking stands out as a core competency, essential for lifelong learning, informed decision-making, and effective participation in a knowledge-based society. The urgency to foster critical thinking is particularly pronounced in secondary education, a pivotal stage where students consolidate cognitive abilities and prepare for higher education or entry into the workforce (Gitadewi, 2024).

Traditional models of teaching, often dominated by rote memorization and teacher-centered instruction, have been increasingly criticized for their inability to cultivate the deep, transferable skills required for the demands of modern life. Instead, there is a growing consensus among educators, policymakers, and researchers that student-centered, inquiry-driven pedagogies are more effective in promoting critical thinking and problem-solving abilities. One such approach that has garnered significant attention and empirical support is Problem-Based Learning (PBL) (Garil, 2024).

Problem-Based Learning is an instructional model that places students at the center of the learning process, engaging them in the exploration and resolution of authentic, complex problems. Rather than passively receiving information, students in PBL environments are challenged to identify what they need to learn, conduct research, collaborate with peers, and apply their knowledge to devise and justify solutions. Teachers act as facilitators, guiding inquiry, scaffolding learning, and fostering metacognitive reflection. This dynamic, interactive process is designed to mirror real-world problem-solving and to stimulate the development of critical thinking competencies (Worachak et al., 2023).

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Empirical evidence from diverse educational contexts supports the efficacy of PBL in enhancing learning outcomes and fostering essential skills. For instance, a meta-analysis of PBL in vocational education found a significant effect size (1.02), indicating a very high impact of the PBL model on learning outcomes, particularly in fostering student autonomy, soft skills, and readiness for workforce demands. These findings are echoed in secondary education settings, where PBL has been shown to promote deep engagement, motivation, and the development of higher-order thinking skills. In mathematics education, for example, problem-based tasks have been found to encourage not only problem-solving but also investigation, creativity, and critical analysis, moving beyond routine practice and memorization (Arifin, 2021).

The integration of PBL is not limited to a single discipline. In science education, PBL has been leveraged to develop inquiry skills, with students engaging in the formulation of research questions, hypothesis testing, data collection, and critical evaluation of evidence. Such experiences foster a scientific mindset and the ability to think critically about complex phenomena. In civics education, PBL has demonstrated its capacity to enhance students' understanding of democratic processes, collaboration, and critical deliberation, leading to improved academic performance and civic competence. Furthermore, the contextualization of PBL through the integration of ethnoscience or culturally relevant content has been shown to make learning more meaningful and directly applicable to students' lives, thereby strengthening critical thinking and bridging gaps in educational practice (Ayerbe-López & Perales-Palacios, 2023).

Despite these promising outcomes, the implementation of PBL in secondary education is not without challenges. Teachers often face difficulties in designing authentic, open-ended problems that are appropriately challenging and relevant to students' experiences. The transition from traditional to PBL-oriented instruction requires significant shifts in pedagogical beliefs, classroom management, and assessment practices. Time constraints, curriculum coverage pressures, and limited resources can further complicate the adoption of PBL, particularly in under-resourced schools. Additionally, students may initially struggle with the demands of self-directed learning and collaborative problem-solving, necessitating careful scaffolding and support from educators (Pozuelo-Muñoz et al., 2023).

Nevertheless, the potential benefits of PBL for developing critical thinking competencies are substantial. By engaging students in active inquiry, encouraging collaboration, and fostering metacognitive reflection, PBL creates a learning environment that mirrors the complexities of real-world problem-solving. Students learn to analyze information critically, evaluate evidence, consider multiple perspectives, and justify their reasoning—skills that are indispensable for academic success and responsible citizenship.

The relevance of PBL is further underscored by ongoing educational reforms in Indonesia and other countries, which increasingly emphasize the development of competencies over content memorization. The Indonesian national curriculum, for example, explicitly identifies critical thinking as a key outcome of secondary education, aligning with global trends in competency-based education. Yet, realizing these ambitions requires a nuanced understanding of how PBL can be effectively integrated into diverse educational contexts, what factors facilitate or hinder its implementation, and how its impact on critical thinking can be meaningfully assessed.

Recent studies provide valuable insights into these questions. For example, research on the integration of ethnoscience with PBL in Nigerian secondary schools demonstrated significant gains in students' critical thinking abilities compared to traditional expository teaching, highlighting the importance of cultural relevance and contextual learning. In Spain, the implementation of PBL in environmental education projects led to high levels of motivation, participation, and socialization among students, despite challenges related to time management and group work. These findings suggest that while PBL holds great promise, its success depends on careful adaptation to local contexts, ongoing professional development for teachers, and the creation of supportive learning environments (Suryanti et al., 2023).

Moreover, the assessment of critical thinking in PBL contexts presents its own set of challenges. Traditional tests may not capture the depth and breadth of students' critical thinking skills, which are often demonstrated through processes such as inquiry, argumentation, and reflection. Alternative assessment methods, such as portfolios, self-assessment, and performance-based tasks, are increasingly advocated as more authentic measures of students' competencies. The development and validation of such assessments remain an important area for further research and innovation.

In sum, the integration of Problem-Based Learning in secondary education represents a significant shift towards more dynamic, student-centered, and competency-oriented teaching and learning. It aligns with the demands of the 21st century, the aspirations of national education policies, and the growing body of evidence on effective pedagogy. However, the journey from policy to practice is complex, requiring sustained commitment, collaboration, and innovation among educators, administrators, and policymakers.

This article seeks to contribute to this endeavor by providing a comprehensive analysis of the integration of Problem-Based Learning for the development of critical thinking competencies in secondary education. Through a qualitative research approach, the study explores the strategies, challenges, and outcomes of PBL implementation in diverse secondary school settings. It aims to answer the following research questions: (1) How can PBL be effectively integrated into secondary education curricula to develop critical thinking competencies? (2) What are the key challenges

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and enablers in implementing PBL approaches in secondary classrooms? (3) What impact does PBL integration have on students' critical thinking development and academic performance?

By addressing these questions, the study not only adds to the scholarly discourse on PBL and critical thinking but also offers practical recommendations for educators and policymakers seeking to foster these essential competencies. Ultimately, the goal is to support the creation of learning environments that empower students to become critical thinkers, problem-solvers, and active contributors to their communities and the wider world.

The structure of this article is as follows. Following this introduction, the literature review synthesizes current research on critical thinking, PBL, and their intersection in secondary education. The methodology section outlines the qualitative research design, data collection, and analysis procedures. The results and discussion present the main findings regarding PBL implementation strategies, challenges, and impacts on critical thinking competencies. Finally, the conclusion summarizes key insights and implications for practice and future research.

In embracing Problem-Based Learning as a vehicle for critical thinking development, secondary education stands at the forefront of educational innovation. The journey is complex, but the potential rewards—for students, educators, and society at large—are profound. As the evidence base grows and best practices are refined, the integration of PBL offers a promising pathway toward realizing the full potential of secondary education in the 21st century.

II. METHODS

This study employed a qualitative research methodology to investigate the integration of Problem-Based Learning for developing critical thinking competencies in secondary education. A qualitative approach was selected because it allows for an in-depth exploration of the complex processes involved in implementing PBL and its effects on critical thinking development. The research design incorporated elements of case study and phenomenological approaches to capture both the contextual factors and lived experiences of participants.

The study was conducted over a period of eight months, allowing for prolonged engagement with the research sites and participants. This extended timeframe enabled the observation of PBL implementation across different units of study and provided opportunities to document changes in students' critical thinking competencies over time. The research design was flexible and iterative, allowing for adjustments based on emerging findings and participant feedback (Nemakhavhani, 2024).

Research Sites and Participants

The research was conducted in four secondary schools in Indonesia, selected through purposive sampling to represent diverse educational contexts. The selection criteria included schools with varying levels of experience in implementing PBL, different socioeconomic backgrounds, and a mix of urban and semi-urban locations. This diversity allowed for a more comprehensive understanding of the factors that influence PBL implementation across different settings.

Participants in the study included:
16 teachers (4 from each school) who were implementing PBL in their classrooms
8 school administrators (2 from each school) responsible for curriculum and instructional leadership
120 students (30 from each school) participating in PBL-based learning activities

The teachers were selected based on their willingness to participate and their involvement in PBL implementation, regardless of their prior experience with this approach. This allowed the study to capture the experiences of both novice and experienced PBL practitioners. Student participants were selected from grades 10-12 (ages 15-18) to ensure they had sufficient cognitive development to engage in complex critical thinking tasks.

Data Collection Methods

Multiple data collection methods were employed to ensure methodological triangulation and enhance the trustworthiness of the findings. The primary data collection methods included:

Classroom Observations: A total of 64 classroom observations (4 per teacher) were conducted to document PBL implementation practices and student engagement in critical thinking activities. Observations focused on teacher facilitation strategies, student interactions, problem-solving processes, and evidence of critical thinking behaviors. An observation protocol was developed based on established frameworks for critical thinking and PBL implementation.

In-depth Interviews: Semi-structured interviews were conducted with all teacher and administrator participants to explore their experiences, perceptions, and reflections on PBL implementation. Each interview lasted approximately 60-90 minutes and was audio-recorded with participant consent. The interview protocols addressed aspects such as PBL planning and implementation, challenges encountered, support mechanisms, and perceived impacts on student learning.

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Focus Group Discussions: A total of 8 focus group discussions (2 per school) were conducted with student participants to gather their perspectives on PBL experiences and self-perceived development of critical thinking skills. Each focus group included 7-8 students and lasted approximately 45-60 minutes. The discussions explored students' engagement with PBL activities, challenges faced, strategies employed for problem-solving, and perceived benefits for their thinking skills.

Document Analysis: Various documents were collected and analyzed, including lesson plans, assessment tools, student work samples, and school policies related to PBL implementation. These documents provided insights into the formal curriculum, assessment practices, and institutional support for PBL and critical thinking development.

Reflective Journals: Both teachers and students maintained reflective journals throughout the study period, documenting their experiences, challenges, and insights related to PBL and critical thinking development. These journals provided valuable data on the participants' evolving understanding and metacognitive awareness.

Data Analysis Procedures

The data analysis followed a systematic, iterative process based on the principles of qualitative content analysis and thematic analysis. The specific procedures included:

Data Preparation: All interviews and focus group discussions were transcribed verbatim, and observation notes were expanded into detailed field notes. Documents and reflective journals were organized and prepared for analysis. All data were imported into NVivo 12 qualitative data analysis software to facilitate the analysis process.

Coding Process: The analysis began with open coding, where the researchers identified and labeled meaningful segments of data related to PBL implementation and critical thinking development. This was followed by axial coding to identify relationships between codes and develop categories. Finally, selective coding was employed to integrate categories around core themes that addressed the research questions.

Thematic Development: Emerging themes were identified through a constant comparative method, where new data were continuously compared with existing codes and categories. This process allowed for the refinement of themes and the identification of patterns across different data sources and participants.

Cross-case Analysis: Data from the four schools were initially analyzed separately to identify site-specific patterns and then compared across sites to identify common themes and contextual variations. This cross-case analysis enhanced the transferability of the findings by highlighting both common patterns and context-specific factors.

Trustworthiness and Ethical Considerations

Several strategies were employed to enhance the trustworthiness of the research findings:

Triangulation: Methodological triangulation (multiple data collection methods), data source triangulation (multiple participants and sites), and investigator triangulation (multiple researchers involved in data analysis) were employed to enhance the credibility of the findings.

Member Checking: Preliminary findings were shared with participants to verify the accuracy of interpretations and incorporate their feedback. This process ensured that the findings authentically represented the participants' experiences and perspectives.

Peer Debriefing: Regular discussions with colleagues not involved in the study provided opportunities to test emerging interpretations and receive critical feedback. This process helped identify potential biases and alternative explanations for the findings.

Audit Trail: Detailed documentation of the research process, including methodological decisions, data collection procedures, and analytical steps, was maintained throughout the study. This documentation enhances the dependability and confirmability of the findings.

Ethical considerations were addressed through obtaining informed consent from all participants, ensuring confidentiality through the use of pseudonyms, and securing institutional approval from the participating schools and relevant educational authorities. Particular attention was given to ethical considerations related to student participants, including obtaining parental consent and ensuring that the research activities did not disrupt their educational experiences:

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Figure 1. Research Design

III. RESULTS AND DISCUSSION

A. Research Result

This qualitative study examined the integration of Problem-Based Learning (PBL) in secondary education to develop students' critical thinking competencies. Data were collected through classroom observations, interviews with teachers and students, focus group discussions, document analysis, and reflective journals across four secondary schools. The findings are organized into key themes: implementation strategies, challenges and enablers, impact on critical thinking competencies, and influencing factors. The results are supported by qualitative data and triangulated with findings from related studies.

1. Implementation Strategies for PBL Integration

Effective integration of PBL involved several interrelated strategies:

- Scaffolded Implementation: Teachers adopted a gradual approach, starting with structured problems and increasing complexity as students developed autonomy. This scaffolded method helped students build confidence and critical thinking skills progressively.
- Authentic Problem Design: Problems were designed to be relevant, real-world, and aligned with curriculum goals. Teachers often involved students in problem selection to increase engagement and ownership.
- Collaborative Learning Structures: Small group work, peer teaching, and whole-class discussions were central. Structured roles and protocols ensured active participation and accountability.

These strategies resonate with findings from prior research, such as the increased student engagement and critical thinking observed in PBL classrooms in Indonesia and the Philippines (Ningrum et al., 2021).

2. Challenges and Enablers in PBL Implementation

Challenges

Time Constraints and Curriculum Pressure: Teachers reported difficulty balancing PBL activities with mandated curriculum coverage and exam preparation. This often limited the depth of PBL experiences.

- Assessment Alignment: Traditional assessments did not adequately capture critical thinking development, complicating evaluation and documentation of student progress.
- Student Readiness Variability: Differences in students' prior knowledge and self-regulation skills required differentiated support, increasing teacher workload.

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- Resource Limitations: Some schools faced shortages of technology, materials, and collaborative spaces, hindering optimal PBL implementation.

Enablers
Administrative Support: Schools with strong leadership support, resource allocation, and flexible scheduling saw more successful PBL integration.

- Teacher Collaboration: Collaborative planning and peer mentoring enhanced teacher confidence and instructional quality.
- Professional Development: Ongoing training focused on PBL pedagogy and critical thinking strategies was crucial.
- Supportive School Culture: A culture valuing inquiry, student voice, and risk-taking fostered a conducive environment for PBL.

These findings align with challenges and supports identified in multiple studies emphasizing the need for systemic support to sustain PBL (Saepuloh et al., 2021).

3. Impact on Critical Thinking Competencies
The integration of PBL had a significant positive impact on students' critical thinking skills, demonstrated in four key areas:

- Analytical Reasoning: Students showed improved ability to dissect complex problems, identify relevant information, and recognize patterns.
- Evaluation of Evidence: Students became more discerning in assessing the credibility and relevance of information sources.
- Metacognitive Awareness: Reflective practices enhanced students' ability to monitor and regulate their thinking processes.
- Problem-Solving Skills: Students developed flexibility in generating solutions, persistence in overcoming obstacles, and systematic evaluation of alternatives.

These outcomes are consistent with quantitative findings from studies in secondary schools where PBL improved critical thinking test scores from fair to good or above average levels. For example, Lapuz and Fulgencio (2020) reported significant increases in critical thinking proficiency after PBL interventions.

4. Factors Influencing Critical Thinking Development
Several factors were critical in mediating the effectiveness of PBL for critical thinking:

- Teacher Facilitation Quality: Skilled facilitators who balanced guidance with student autonomy, used strategic questioning, and modeled critical thinking processes enhanced student outcomes.
- Explicit Critical Thinking Instruction: Integrating direct teaching of critical thinking strategies within PBL activities amplified skill development.
- Assessment and Feedback Quality: Formative assessments with specific, process-oriented feedback supported students' reflective growth.
- Duration and Depth of PBL Experiences: Extended, in-depth PBL units yielded more substantial critical thinking gains compared to short, isolated activities.

These factors underscore the complexity of fostering critical thinking and the necessity of intentional instructional design and support.

Table 1. Impact on Critical Thinking Competencies

Factor	Description	Impact on Critical Thinking Competencies	Supporting Evidence/Quotes
Implementation Strategies	Scaffolded approach, authentic problem design, collaborative learning	Facilitated gradual skill development, engagement, and higher-order thinking	"We started with structured problems and gradually moved to open-ended ones… students gained confidence."
Challenges	Time constraints, assessment misalignment, student readiness variability, resource limitations	Limited depth and consistency of critical thinking development	"Balancing curriculum coverage and PBL is tough… sometimes we rush the process."

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Enablers	Administrative support, teacher collaboration, professional development, supportive culture	Enabled sustained, effective PBL implementation	"Strong leadership and teamwork among teachers made PBL work well in our school."
Analytical Reasoning	Improved problem breakdown, pattern recognition, information relevance	Enhanced students' ability to analyze complex problems	"Students now analyze problems more methodically before jumping to conclusions."
Evaluation of Evidence	Increased discernment of source credibility, bias, and evidence strength	Better information evaluation and decision-making	"Students question sources more critically and seek stronger evidence."
Metacognitive Awareness	Reflective practices, self-monitoring, and regulation of thinking	Greater self-awareness and control over cognitive processes	"I catch myself making assumptions and try to think more carefully now."
Problem-Solving Skills	Flexibility, persistence, systematic testing of solutions	More effective and creative problem-solving	"Students consider multiple solutions and don't give up easily."
Teacher Facilitation Quality	Strategic questioning, balanced guidance, modeling critical thinking	Crucial for deepening student engagement and thinking	"Effective facilitation makes critical thinking visible and accessible to students."
Explicit Critical Thinking Instruction	Direct teaching of thinking strategies integrated with PBL	Amplified skill acquisition and application	"Teaching thinking frameworks helped students organize their reasoning."
Assessment and Feedback Quality	Formative, process-focused feedback, self and peer assessment	Supported reflective growth and skill refinement	"Feedback on thinking processes, not just answers, helped students improve."
Duration and Depth of PBL	Extended, complex PBL units vs. short activities	Longer engagements led to stronger critical thinking development	"Sustained projects allowed students to grapple with complexity and reflect deeply."

B. Discussion

The integration of Problem-Based Learning (PBL) in secondary education to develop critical thinking competencies has been widely recognized as an effective pedagogical approach that aligns with the demands of 21st-century education. This discussion elaborates on the findings of this study in relation to existing literature, highlighting the multifaceted nature of PBL implementation, its impact on critical thinking development, and the contextual factors that influence its success in secondary education settings.

Effectiveness of PBL in Developing Critical Thinking Competencies

The findings of this study confirm that PBL significantly enhances critical thinking competencies among secondary school students. This aligns with previous research that emphasizes PBL's capacity to engage students in authentic, complex problem-solving activities that require analysis, evaluation, and reflection—core components of critical thinking Hmelo-Silver, Lapuz & Fulgencio in Hidayani (2024). The scaffolded implementation approach observed in this study allowed students to gradually develop autonomy and confidence in their critical thinking abilities, which is consistent with constructivist theories advocating for learner-centered and progressively challenging tasks (Sandra Dwi Hidayani, 2024). The improvement in analytical reasoning, evaluation of evidence, metacognitive awareness, and problem-solving skills observed here mirrors findings from other contexts. For example, the Classroom Action Research conducted in Civic Education (PPKn) in Indonesia demonstrated that PBL not only improved academic achievement but also fostered students' motivation and engagement by integrating local historical values, which deepened their understanding and critical reflection on national identity). Similarly, in mathematics education, problem-based tasks have been shown to promote investigation, creativity, and critical thinking beyond routine memorization). These parallels reinforce the notion that PBL's emphasis on real-world relevance and collaborative inquiry creates fertile ground for critical thinking development across disciplines.

Implementation Strategies and Their Role in Critical Thinking Development

The study highlights three main strategies that facilitated effective PBL integration: scaffolded implementation, authentic problem design, and collaborative learning structures. Scaffolded implementation was particularly important in helping

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students transition from teacher-led instruction to self-directed inquiry. This gradual release of responsibility aligns with Vygotsky's Zone of Proximal Development, where learners benefit from guided support before independently tackling complex tasks (Mejias et al., 2024).

Authentic problem design was another critical factor. Problems that were relevant to students' lives and connected to real-world issues increased motivation and engagement, which are essential for sustained critical thinking. The involvement of students in problem selection further enhanced ownership and intrinsic motivation, which has been shown to deepen cognitive engagement and promote higher-order thinking skills.

Collaborative learning structures provided opportunities for students to articulate their reasoning, challenge assumptions, and consider diverse perspectives. This social dimension of learning is central to the development of critical thinking, as it encourages dialogue, argumentation, and reflection. The structured roles and protocols implemented helped ensure equitable participation and accountability, addressing common challenges in group work such as social loafing and dominance by certain members (Yawan, 2022).

Challenges in Implementing PBL in Secondary Education

Despite its benefits, the study identified several challenges that resonate with existing literature. Time constraints and curriculum pressure were recurrent themes, with teachers struggling to balance the demands of mandated content coverage and examination preparation with the time-intensive nature of PBL activities. This challenge has been widely reported in Indonesian classrooms and beyond, where rigid curricula and high-stakes testing limit opportunities for deep inquiry and reflection (Suryanti et al., 2023).

Assessment misalignment was another significant barrier. Traditional assessments often fail to capture the complex, process-oriented skills developed through PBL, such as reasoning, collaboration, and metacognition. Teachers expressed difficulty in designing and implementing assessments that authentically measure critical thinking competencies, a concern echoed in studies on competency-based curriculum. This gap underscores the need for systemic reforms in assessment practices to support innovative pedagogies like PBL.

Variability in student readiness also posed challenges. Differences in prior knowledge, motivation, and self-regulation required differentiated scaffolding, increasing the complexity of classroom management and instructional planning. This finding aligns with research highlighting the importance of teacher competence and adaptive strategies in managing diverse classrooms during PBL implementation.

Resource limitations, including insufficient access to technology, learning materials, and collaborative spaces, were particularly pronounced in under-resourced schools. While emerging technologies such as Augmented Reality offer promising avenues to enrich PBL and critical thinking activities, their integration is constrained by infrastructural and technological challenges in many Indonesian secondary schools.

Enablers and Support Systems for Successful PBL Integration

The study identifies several enablers that can mitigate challenges and enhance PBL effectiveness. Strong administrative support emerged as a foundational element, providing necessary resources, professional development opportunities, and flexible scheduling. This finding is consistent with literature emphasizing the role of school leadership in fostering a culture conducive to pedagogical innovation).

Teacher collaboration and ongoing professional development were also critical. Collaborative planning and peer mentoring helped teachers build confidence, share best practices, and refine their facilitation skills. Professional development that combines theoretical knowledge with practical application, including coaching and reflective practice, is essential for sustaining PBL implementation). The importance of teacher preparedness is further underscored by the study on Computational Thinking integration, which highlights that successful adoption of innovative pedagogies requires holistic reforms encompassing leadership, technology, and curriculum adjustments).

A supportive school culture that values inquiry, risk-taking, and student voice was another enabler. Such an environment encourages experimentation and resilience among both teachers and students, facilitating deeper engagement with PBL processes.

Impact of PBL on Critical Thinking Competencies

The study's findings on the development of critical thinking competencies are multifaceted. Students demonstrated enhanced analytical reasoning, characterized by improved ability to dissect complex problems and identify relevant information. This aligns with the cognitive processes described in critical thinking frameworks, which emphasize analysis as a foundational skill.

Evaluation of evidence improved markedly, with students showing greater discernment in assessing source credibility, bias, and the strength of arguments. This skill is particularly crucial in an era of information overload and misinformation, underscoring PBL's relevance in preparing students for informed citizenship.

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Metacognitive awareness was another significant outcome. Through reflective journals and discussions, students became more conscious of their thinking processes, enabling self-regulation and strategic learning. Metacognition is widely recognized as a key component of critical thinking, facilitating transfer of skills across contexts).
Finally, problem-solving capabilities were enhanced, with students exhibiting flexibility, persistence, and systematic evaluation of solutions. These skills are essential not only for academic success but also for navigating complex real-world challenges.

Factors Influencing Critical Thinking Development Through PBL
Several factors mediated the effectiveness of PBL in fostering critical thinking. Teacher facilitation quality was paramount; skilled facilitators who employed strategic questioning, balanced guidance with autonomy, and modeled critical thinking processes significantly deepened student engagement and skill development. This finding echoes research advocating for the role of teachers as cognitive coaches in PBL environments.
Explicit instruction in critical thinking strategies integrated within PBL activities amplified student learning. Providing students with frameworks, terminology, and metacognitive tools helped them navigate the complexities of problem-solving and reflection more effectively.
Assessment and feedback practices also played a crucial role. Formative assessments that focused on thinking processes rather than solely on final products supported students' reflective growth and skill refinement. Incorporating self-assessment and peer feedback further enhanced metacognitive awareness and collaborative learning.
The duration and depth of PBL experiences influenced outcomes; sustained engagement with complex problems over extended periods yielded more substantial gains than short, isolated activities. This finding suggests that critical thinking development requires time and repeated practice, aligning with theories of skill acquisition and transfer.

IV. CONCLUSIONS

This study affirms the transformative potential of Problem-Based Learning in developing critical thinking competencies in secondary education. Effective implementation requires scaffolded strategies, authentic problems, collaborative learning, and skilled facilitation. While challenges related to time, assessment, and resources persist, systemic support and professional development can enable sustainable adoption. The enhanced analytical, evaluative, metacognitive, and problem-solving skills observed among students underscore PBL's alignment with 21st-century educational goals. Policymakers and educators are encouraged to embrace and adapt PBL within curricula, assessments, and school cultures to prepare students for the complexities of the modern world.

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