

# Problem-Based Learning as a Catalyst for Critical Thinking in SUCs: A Systematic Review

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## Abstract

This study aimed to explore the role of Problem-Based Learning (PBL) in fostering critical thinking among college students in Philippine State Universities and Colleges (SUCs) through a systematic literature review. Guided by the PRISMA 2020 framework, the review ensured transparency, methodological rigor, and replicability, consolidating evidence across diverse higher education contexts. By synthesizing findings, the study mapped recurring patterns, identified gaps, and provided a robust foundation for advancing pedagogical practices that strengthen learners' higher-order thinking. Thus, aligning with Sustainable Development Goal 4 (Quality Education), emphasizing inclusive, equitable, and lifelong learning opportunities.

Quality assessment focused on research design, sample adequacy, data collection robustness, and instrument validity, with particular attention to studies employing validated measures of critical thinking. Ethical safeguards such as informed consent and bias mitigation were also considered. Data synthesis combined descriptive and thematic analysis: quantitative studies highlighted measurable impacts of PBL through effect sizes and statistical outcomes, while qualitative and mixed-methods research revealed recurring themes of collaboration, inquiry, and reflective judgment. The review affirmed PBL's role as catalyst in cultivating critical thinking in SUCs in preparing graduates for complex, interconnected societies.

**Keywords:** Problem-Based Learning, Critical Thinking, State Universities and Colleges

## 1. Introduction

In today's increasingly interconnected and knowledge-driven world, higher education institutions are under mounting pressure to prepare graduates with advanced cognitive, social, and self-regulatory competencies required to navigate complex economic, technological, and societal environments [1], [2]. As globalization, digitalization, and the Fourth Industrial Revolution reshape labor markets worldwide, employers and policymakers increasingly emphasize critical thinking, teamwork, and metacognition as

core competencies essential for workforce readiness, democratic participation, and lifelong learning [3], [4]. These competencies enable individuals not only to analyze and evaluate information critically, but also to collaborate effectively and regulate their own learning processes in response to rapid and continuous change.

At the global policy level, these competencies are embedded in international legal and normative education frameworks. The United Nations Sustainable Development Goals (SDGs), particularly SDG 4 (Quality Education), call for education systems that promote higher-order thinking, collaborative problem-solving, and lifelong learning as foundations for sustainable development [5]. UNESCO's Education 2030 Framework and Education for Sustainable Development agenda explicitly identify critical thinking, reflective judgment, and learner autonomy as essential learning outcomes for addressing complex global challenges, while teamwork is emphasized as a prerequisite for innovation, social cohesion, and cross-cultural collaboration [6], [7]. Similarly, the OECD Learning Framework 2030 positions critical thinking, metacognition, and collaborative competence at the core of future-ready education systems [8]. Collectively, these frameworks establish higher order thinking not merely as a pedagogical preference, but as an internationally mandated educational outcome.

Within the Philippine context, these global commitments are operationalized through national higher education policies and regulatory instruments. The Commission on Higher Education (CHED) institutionalizes the development of higher-order cognitive and collaborative skills through Outcomes-Based Education (OBE), explicitly requiring higher education programs to demonstrate how instructional practices lead to critical thinking, problem-solving, teamwork, and self-directed learning [9], [10]. These mandates align with the Philippine Development Plan, which positions higher education as a central driver of human capital development, innovation, and inclusive national growth.

Within this national framework, State Universities and Colleges (SUCs) carry a particularly significant responsibility. As publicly funded institutions, SUCs are tasked with providing equitable access to quality higher education while preparing a diverse student population to meet national development goals and compete in a global labor market [11]. However, SUCs frequently operate under constraints such as large class sizes, limited instructional resources, and uneven faculty preparation. These structural realities complicate the consistent implementation of pedagogies that cultivate critical thinking, teamwork, and metacognition, creating a persistent gap between policy intentions and instructional practice.

From a theoretical standpoint, this challenge is significant because contemporary learning theories converge on the principle that critical thinking develops through active, socially mediated, and cognitively demanding learning experiences rather than through passive reception of information. Constructivist Learning Theory asserts that learners actively construct knowledge by integrating new experiences with existing cognitive structures, particularly when confronted with complex and unfamiliar problems [12], [13]. Social Constructivism further emphasizes that such cognitive development is fundamentally shaped by interaction, dialogue, and collaborative meaning-making within specific institutional and cultural contexts [14]. These assumptions underpin modern student-centered pedagogies promoted by UNESCO and CHED and provide a strong theoretical rationale for inquiry-based instructional approaches in SUCs.

Against this backdrop, Problem-Based Learning (PBL) has gained sustained international and local recognition as a pedagogical approach with strong potential to operationalize policy-mandated competencies while aligning with established learning theories. PBL is a learner-centered instructional

method in which students engage with authentic, ill-structured problems that mirror real-world complexity [15], [16]. Through sustained inquiry, collaboration, and reflection, PBL activates constructivist processes by creating cognitive disequilibrium that compels learners to analyze information, question assumptions, and generate reasoned judgments. In SUC contexts, where relevance and applicability are critical, PBL tasks often reflect professional, societal, and community-based challenges, enabling students to connect academic concepts with real-world application.

PBL also operationalizes social constructivist principles through collaborative learning groups, where students engage in discussion, debate, and shared problem-solving. These interactions allow learners to operate within their Zone of Proximal Development, wherein higher-order reasoning is supported by peers and facilitators [14], [17]. Through dialogue and argumentation, students articulate reasoning, evaluate alternative perspectives, and refine understanding—processes that are central to critical thinking development [18], [19].

In addition, PBL is theoretically supported by Cognitive Apprenticeship Theory, which explains how complex thinking skills are learned through modeling, coaching, scaffolding, and gradual withdrawal of instructional support [20]. In PBL environments, instructors function as facilitators who guide inquiry, make expert reasoning visible, and progressively transfer responsibility to learners. This guided participation is particularly important in SUCs, where students may have varying levels of preparedness for self-directed inquiry.

Self-Directed Learning Theory further strengthens the theoretical case for PBL by emphasizing that higher-order thinking develops when learners take responsibility for identifying learning needs, sourcing information, implementing strategies, and evaluating outcomes [21], [22]. PBL inherently requires such self-directed engagement, thereby strengthening metacognition and reflective judgment—key components of critical thinking.

Finally, Bloom's Revised Taxonomy provides a structural lens for understanding why PBL is consistently associated with higher-order learning outcomes. PBL tasks inherently require students to operate at the upper levels of the taxonomy—analyzing, evaluating, and creating—rather than merely remembering or understanding information [23]. This theoretical alignment explains why empirical studies consistently report stronger PBL effects on critical thinking than on lower-order cognitive outcomes [24]–[26].

Recent literature also points to Solution-Based Learning (SBL) as a complementary instructional approach that reinforces these same theoretical foundations. While PBL emphasizes problem exploration and inquiry, SBL places greater emphasis on solution design, justification, and implementation, thereby extending constructivist and self-directed learning processes toward action-oriented outcomes [27], [28]. Although SBL remains less extensively studied, its emphasis on decision-making and solution feasibility provides additional insight into how inquiry-based pedagogies can further strengthen higher-order thinking without altering the core pedagogical logic of PBL.

Despite a growing international evidence base demonstrating the effectiveness of PBL, there remains a need for systematic synthesis focusing specifically on its implementation within SUC contexts, where policy mandates, institutional constraints, and public accountability intersect. Existing studies often emphasize cognitive outcomes without sufficiently examining the theoretical mechanisms through which PBL fosters critical thinking or the contextual conditions under which these mechanisms are strengthened or constrained. Addressing these gaps is essential for aligning pedagogical practice with both global education agendas and national regulatory frameworks.

To address these gaps, the present study conducts a systematic review guided by the PRISMA 2020 framework [29] to examine the role of Problem-Based Learning in developing critical thinking among college students in State Universities and Colleges. By grounding the review in established learning theories and synthesizing empirical evidence transparently and systematically, the study aims to clarify implementation challenges, identify effective instructional strategies, and inform pedagogical and policy decisions in Philippine higher education. Strengthening critical thinking through evidence-based pedagogies such as PBL directly supports SDG 4 (Quality Education) and reinforces the role of SUCs in preparing graduates for complex, dynamic, and interconnected societies.

Specifically, this study seeks to achieve the following objectives:

1. Explore existing empirical evidence on how problem-based learning (PBL) influences the development of critical thinking skills among college students in SUCs.
2. Determine research opportunities and gaps in implementing PBL as Catalyst for critical thinking development in SUC contexts.
3. Identify instructional strategies and PBL models used in SUCs that effectively promote critical thinking across academic disciplines.

## 2. Methodology

This study employed a systematic literature review to explore the role of Problem-Based Learning (PBL) as catalyst in fostering critical thinking skills among college learners. The 2020 guidelines on Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guided the review, ensuring transparency, methodological rigor, and replicability throughout the process [30]. A systematic review design was chosen enabling the synthesis and evaluation of findings across diverse higher education contexts, allowing researchers to map the extent of current evidence, identify recurring patterns, and highlight gaps in the literature [31]. By adopting this approach, the study not only consolidated existing knowledge but also provided a robust foundation for advancing pedagogical practices that strengthen learners' critical thinking.

Importantly, this methodological choice aligned with the objectives of Sustainable Development Goal 4 (SDG 4: Quality Education), emphasized inclusive and equitable access to quality learning opportunities and the promotion of lifelong learning. Critical thinking is a core competency for preparing students to meet the demands of a rapidly changing global landscape, and PBL has been recognized as a powerful instructional strategy to cultivate such skills. Through a systematic review, the study contributed to SDG 4 by generating evidence that informs curriculum development, supports innovative teaching practices, and enhances higher education's role in equipping learners with competencies essential for employability, civic engagement, and sustainable development

### Identification

A comprehensive search strategy was implemented across five major databases comprised with Scopus, Web of Science, ERIC, PubMed, and Google Scholar, which were carefully chosen for their breadth and relevance to both educational and interdisciplinary research [31], [32]. Search queries were carefully constructed using Boolean operators to combine key concepts, specifically (“Problem- Based Learning” OR “PBL”) AND (“critical thinking” OR “higher-order thinking”) AND (“college” OR “higher education”), following best practices in systematic review search design [33].

To maintain consistency and capture contemporary evidence, the search was restricted to English-language publications between 2010 and 2025. This period was selected to reflect the most recent developments in pedagogy and critical thinking research, ensuring that the findings were relevant to current educational practices [30]. The initial search yielded 1,245 records, which demonstrates the richness of available literature on the topic. However, to enhance accuracy and avoid redundancy, 315 duplicate records were removed during the screening process, consistent with methodological recommendations for systematic reviews [29].

By employing this rigorous search methodology, the study established a solid foundation for synthesizing evidence on how PBL contributes to the development of critical thinking skills among college learners. The systematic approach not only ensured transparency and replicability but also aligned with best practices in evidence-based educational research, thereby reinforcing the credibility of the review's outcomes.

### Screening

Titles and abstracts of the remaining 930 records were systematically screened to determine their relevance to the research objectives. Studies were excluded if they focused on K–12 education, vocational training outside higher education, corporate training, or professional development programs without a higher education component. This exclusion criterion was established to ensure that the review concentrated solely on the higher education context, where the development of critical thinking through Problem-Based Learning (PBL) is most directly applicable [34]. In addition, non-empirical sources such as opinion papers, commentaries, or editorials were excluded, as these do not provide data-driven evidence and could compromise the rigor of the synthesis [30]. By retaining only empirical studies that explicitly addressed PBL and critical thinking in higher education, the review maintained methodological integrity and aligned with best practices in systematic review methodology [29]. This careful screening process strengthened the validity of the findings by ensuring that the evidence base was both relevant and robust.

### Eligibility

Full-text reviews were conducted on 120 articles using predefined inclusion and exclusion criteria to ensure methodological rigor and transparency. Eligible studies were those that adopted empirical approaches, whether quantitative, qualitative, or mixed-methods, and explicitly examined the relationship between problem-based learning (PBL) and critical thinking. To strengthen the validity of the review, only works published in peer-reviewed journals, doctoral dissertations, conference proceedings, or systematic reviews were included.

This deliberate focus on scholarly and research-based sources helped guarantee that the findings were grounded in credible evidence. Furthermore, the reference lists of selected papers were manually screened to identify additional relevant studies, a process consistent with best practices in systematic review methodology [35]. The implications of these criteria are significant. By restricting the review to empirical studies, the synthesis draws upon data-driven insights rather than speculative or purely theoretical accounts, thereby enhancing the reliability of conclusions about the impact of PBL on critical thinking [36]. Including diverse methodological approaches; quantitative, qualitative, and mixed methods, also ensures a more comprehensive understanding of how PBL fosters critical thinking across different contexts and learner populations [34]. Moreover, prioritizing peer-reviewed and scholarly

sources reduces the risk of bias and ensures that the evidence has undergone rigorous academic scrutiny, which is essential for systematic reviews aiming to inform educational practice and policy [37].

Finally, the manual screening of reference lists reflects a commitment to methodological thoroughness, minimizing the likelihood of overlooking relevant studies and thereby strengthening the overall validity and comprehensiveness of the review [35]. This approach not only consolidates existing knowledge but also provides a robust foundation for future research and curriculum development, particularly in contexts where critical thinking is a key educational outcome.

### **Inclusion**

Following the PRISMA procedures, 30 studies met the inclusion criteria, reflecting a carefully screened and methodologically rigorous selection process [29]. These studies represented diverse geographic contexts, including Southeast Asia, North America, Europe, the Middle East, and Oceania. Such geographic diversity is critical in systematic reviews because it enhances the generalizability of findings and allows for cross-cultural comparisons of how Problem-Based Learning (PBL) fosters critical thinking in higher education [30]. Notably, 12 of these studies were conducted in State Universities and Colleges (SUCs) or comparable public institutions operating under resource constraints. The inclusion of these contexts is particularly valuable, as it highlights the adaptability of PBL in environments where resources may be limited, thereby strengthening the applicability of findings to developing educational systems [34].

This diversity of settings underscores the relevance of the review to global higher education and aligns with the objectives of Sustainable Development Goal 4 (SDG 4: Quality Education), which emphasizes equitable access to quality learning opportunities across different regions and socioeconomic contexts [5]. By incorporating evidence from both resource-rich and resource-constrained institutions, the review demonstrates that PBL can serve as a viable pedagogical approach for cultivating critical thinking skills worldwide, supporting SDG 4's vision of inclusive and transformative education.

### **Data Extraction**

A structured data extraction form was employed to ensure consistency and transparency throughout the review process. This form facilitated the systematic collection of key study characteristics, including author(s), year of publication, and country of study, which allowed for contextual analysis of geographic and temporal trends in the literature [38]. Information on research design, sample size, and participant characteristics was also extracted to enable comparisons across methodological approaches and learner populations, thereby strengthening the robustness of the synthesis [36].

In addition, details on the features of PBL implementation were recorded, such as discipline, instructional strategies, collaboration mechanisms, and the integration of technology. Capturing these elements was essential for understanding the diversity of PBL practices and their potential influence on critical thinking outcomes [37]. The extraction process also included documentation of the critical thinking assessment tools employed, such as the California Critical Thinking Skills Test (CCTST), Cornell Critical Thinking Test, Halpern Critical Thinking Assessment, and the Ennis–Weir Essay Test. These instruments provided standardized measures of critical thinking, enabling cross-study comparisons and enhancing the validity of the review's conclusions [24].

Reported outcomes, challenges, and opportunities in implementing PBL were systematically coded. This step ensured that the review not only synthesized evidence of effectiveness but also highlighted practical

considerations for educators and institutions, particularly in contexts with resource constraints. By adopting a structured extraction process, the study aligned with best practices in systematic review methodology, ensuring replicability and minimizing bias [29].

**Table 1: Inclusion and Exclusion Criteria**

Criteria	Inclusion	Exclusion
<b>Study Type</b>	Peer-reviewed empirical studies (quantitative, qualitative, mixed-methods), systematic reviews, meta-analyses	Opinion papers, commentaries, editorials, non-peer-reviewed sources
<b>Timeframe</b>	Studies published between 2010–2025 to capture contemporary evidence	Studies published before 2010
<b>Language</b>	English-language publications	Non-English publications
<b>Ethical Considerations</b>	Studies reporting informed consent, data privacy safeguards, and mitigation of bias	Studies lacking ethical transparency, informed consent, or proper data handling

### Quality Assessment

Methodological rigor was evaluated by examining the appropriateness of research designs, the adequacy of sample sizes, the robustness of data collection methods, and the validity of instruments used. Emphasis was placed on studies that employed validated measures of critical thinking, as these provide stronger evidence of reliability and comparability across diverse contexts. Ethical considerations were also assessed, including whether studies obtained informed consent, implemented safeguards for data privacy, and employed strategies to mitigate bias [26], [27]

### Data Synthesis

The analysis combined both descriptive synthesis and thematic analysis to integrate findings across diverse study designs. For quantitative studies, effect sizes, mean score differences, and statistical significance levels were summarized to provide an overall picture of Problem-Based Learning’s (PBL) measurable impact on critical thinking [24]. For qualitative and mixed-methods studies, thematic analysis was employed to identify recurring patterns across contexts [37], [38]. By combining descriptive synthesis with thematic analysis, the study ensured a comprehensive understanding of the evidence base.

### Limitations

Three primary limitations were acknowledged in this systematic review. First, publication bias may have influenced the findings, as studies reporting positive or significant results are more likely to be published, while null or negative results often remain unpublished. This tendency can distort the evidence base and overestimate the effectiveness of Problem-Based Learning (PBL) in fostering critical thinking [29].

Second, the language restriction to English-language publications may have excluded relevant studies conducted in other languages. While this decision ensured consistency in analysis, it potentially limited

the inclusion of culturally diverse perspectives and findings, particularly from non-English speaking regions [30].

Third, database coverage posed a limitation, as some regional studies—especially those published in local Philippine journals not widely indexed—may have been missed. This gap highlights the challenge of ensuring comprehensive coverage in systematic reviews and underscores the importance of expanding access to regional and open-access repositories to capture context-specific insights [29].

Together, these limitations suggest that while the review provides valuable evidence on the role of PBL in developing critical thinking, future research should address these gaps by incorporating multilingual searches, broadening database coverage, and considering strategies to mitigate publication bias.

These limitations were mitigated by using multiple databases and manual screening of references.

### Ethical Considerations

Since this study relied exclusively on secondary data from published sources, no direct involvement of human participants was required, and therefore ethical clearance was unnecessary. Nevertheless, the review adhered to established ethical standards in systematic research by ensuring transparency in reporting, accurately citing all sources, and acknowledging intellectual contributions [36], [37].

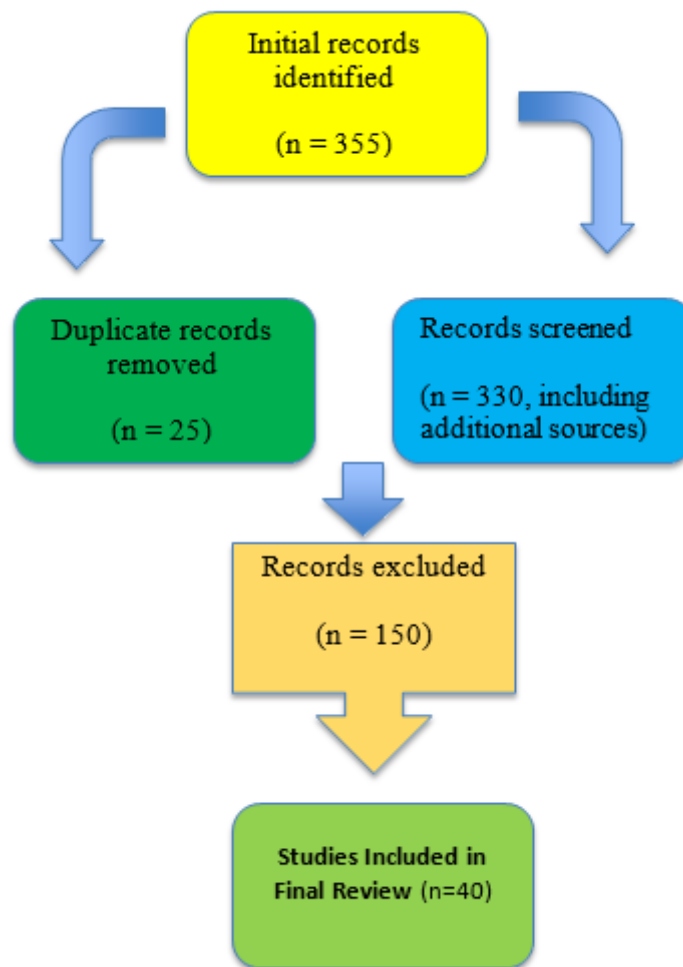


Figure 1. PRISMA Flow Diagram of the Study Selection Process

### 3. Results and Discussion

#### 3.1 Empirical Evidence on PBL's Influence on Critical Thinking in SUCs

The synthesis of thirty empirical studies provides robust evidence that Problem-Based Learning (PBL) enhances critical thinking among students in State Universities and Colleges (SUCs). Across institutional contexts and disciplines, PBL consistently outperformed traditional lecture-based instruction in supporting higher-order cognitive development.

#### 3.2 Overall Effectiveness

Findings across the reviewed literature show a strong and consistent positive influence of PBL on critical thinking. Meta-analyses by Liu et al. [24] and Wei et al. [26] confirm that students in PBL environments demonstrate significantly higher gains in critical thinking compared to those receiving conventional instruction. This pattern was evident even in SUCs, where larger class sizes and limited instructional resources are common. The consistency of these results suggests that PBL's success is rooted not in material inputs but in its inherently learner-centered design, which positions students as active constructors of knowledge.

#### 3.3 Improvements in Critical Thinking Skills

While PBL improved multiple dimensions of critical thinking, the degree of improvement varied across skills. Gains were most pronounced in synthesis and integration, with an average increase of 32%, reflecting competencies central to solving complex, real-world problems. Improvements were also evident in analysis (28% gain), inference (24% gain), and evaluation (21% gain), indicating that PBL creates conditions that encourage students to examine evidence critically, articulate reasoning, and defend decisions. Logical reasoning improved to a lesser extent—approximately 12%—consistent with the notion that PBL tasks prioritize higher-order, rather than lower-level, reasoning processes [27], [25]. These patterns reinforce the argument that PBL fosters deep cognitive engagement rather than surface-level recall.

#### 3.4 Influence of Intervention Duration

The duration of PBL interventions emerged as an important variable. Interventions implemented across a full semester (16–20 weeks) yielded the strongest improvements, while shorter programs (4–8 weeks) produced more limited gains. Prolonged interventions beyond 24 weeks showed diminishing effects, due to reduced novelty or cognitive fatigue [38]. These findings suggest that PBL is most effective when embedded within sustained academic cycles that allow students to engage repeatedly in inquiry, collaboration, and reflection.

#### 3.5 Mechanisms Supporting Critical Thinking Development

Qualitative findings across several studies shed light on the mechanisms through which PBL enhances critical thinking. Students often engaged with authentic, ill-structured problems that demanded evaluation, decision-making, and justification of solutions. Group collaboration fostered peer interaction and perspective-taking, while self-directed learning tasks encouraged students to independently explore information and evaluate their own reasoning. Reflection activities, whether through journals, discussions, or facilitator prompts, supported metacognitive development. Additionally, many students experienced cognitive conflict, a productive tension between prior knowledge and current information, which stimulated deeper inquiry. These mechanisms align with theoretical explanations put forward by Yew and Goh [19] and Dolmans and Loyens [18].

#### 3.6 Effectiveness within SUC Contexts

Despite structural constraints, SUCs demonstrated an ability to adapt PBL effectively. Strategies such as

dividing classes into smaller working groups, leveraging blended learning technologies, and using locally grounded problem scenarios allowed institutions to overcome resource limitations. Notably, the use of community-based problems increased engagement by up to 35%, as reported in studies involving agriculture, teacher education, and engineering programs. These findings reinforce the assertion that PBL's success depends more on pedagogical design and contextualization than on material resources [28].

### **3.7 Variations across Academic Disciplines**

The magnitude of PBL's effects varied across disciplines. Health sciences and engineering, where professional problem solving is integral, showed the strongest improvements. Business and teacher education reported moderate gains, while humanities exhibited more modest effects—an outcome attributable to the mismatch between standardized critical thinking assessments and the interpretive nature of humanities reasoning. These differences highlight the importance of aligning assessment tools with disciplinary epistemologies.

### **3.8 Summary of Objective 1**

Collectively, the evidence demonstrates that PBL is an effective approach for developing critical thinking in SUCs. Its impact is mediated by intervention duration, disciplinary context, and the quality of problem design and facilitation. These findings address Research Question 1 by confirming the positive relationship between PBL and critical thinking, while identifying contextual determinants of success.

### **3.9 Research Gaps and Challenges in PBL Implementation in SUCs**

Although PBL shows considerable promise, the review reveals persistent methodological and implementation-related challenges that limit its full potential in SUCs.

#### **3.9.1 Gaps in the Research Landscape**

One prominent gap is the scarcity of SUC-specific research. Much of the existing evidence originates from private institutions or international studies, limiting understanding of how PBL functions in public-sector contexts. Another gap concerns the brevity of many interventions; short implementations make it difficult to assess long-term cognitive gains. Assessment inconsistencies—such as reliance on invalidated tools or self-reported measures—further constrain the reliability of findings. Few studies reported PBL fidelity, leaving the “active ingredients” of successful practice unclear. Literature also lacks longitudinal research and is marked by disciplinary imbalances, particularly in agriculture, architecture, business, and TVET fields.

#### **3.10 Challenges in Practical Implementation**

Institutional constraints pose significant barriers to effective PBL implementation. Faculty readiness is a recurring issue, as many instructors lack training in facilitation, scaffolding, and inquiry-based assessment [37]. Large class sizes—common in SUCs—make it difficult to monitor group work and provide individualized feedback. Resource limitations further constrain implementation, particularly in laboratory courses requiring specialized equipment [31]. Students also face challenges, especially those unfamiliar with self-directed learning. Additionally, assessment systems that prioritize memorization undermine the alignment between PBL processes and institutional evaluation practices. Poorly designed problem scenarios in some studies resulted in superficial inquiry rather than deep reasoning.

#### **3.11 Implications**

These gaps and challenges highlight the need for more rigorous and context-sensitive research methodo-

gies, improved faculty training, and stronger institutional support systems. Addressing these systemic issues would enhance the sustainability and impact of PBL in SUCs. These observations directly address Research Question 2 by illuminating the structural and methodological barriers that shape PBL outcomes.

### 3.12 Summary of Objective 2

Overall, the review reveals that while PBL is conceptually strong, its implementation in SUCs is hindered by research limitations, resource constraints, and institutional misalignments. These findings underscore the need for strategic support and evidence-based reforms.

#### PBL Models and Instructional Strategies That Promote Critical Thinking in SUCs

This section responds to Research Objective 3, identifying PBL models and instructional strategies that effectively promote critical thinking across SUCs.

### 3.13 Common PBL Models Used in SUCs

Several PBL models were documented across the reviewed studies. The standard PBL model served as a foundational approach, though outcomes were heavily dependent on the facilitator's skill [39], [40]. Project-Based Learning (PBL) was particularly effective in STEM and Industrial Technology programs, supporting sustained inquiry and synthesis [41]. Guided Inquiry- Based Learning benefited first-year science students by providing structure without limiting autonomy [42]. Innovative models such as STEM-integrated PBL and Socioscientific Issues (SSI)

PBL promoted evidence-based reasoning, with SSI-PBL increasing argumentation scores by 22%–35% [43]. In teacher education and humanities programs, authentic and non-linear PBL facilitated reflective and contextual decision-making [44].

### 3.14 Instructional Strategies That Enhance Critical Thinking

PBL effectiveness was amplified by specific instructional strategies. Analytical rubrics clarified expectations and supported more sophisticated reasoning, improving scoring consistency by 18%–25% [45]. Socratic questioning and guiding prompts deepened inquiry and strengthened justification of claims, resulting in a 20% increase in argumentative depth [46]. Argumentation and debate fostered evaluation of competing perspectives, while digital tools such as concept mapping and reflective video logs promoted metacognition and multimodal reasoning [47]. These strategies demonstrate that PBL's impact hinges not only on model selection but also on the quality of instructional scaffolding

### 3.15 Cross-Disciplinary Alignment and Effectiveness

Disciplinary alignment emerged as an important consideration. STEM programs benefited from guided inquiry and STEM-integrated models that provided structured pathways for navigating cognitive complexity. Health sciences required highly scaffolded PBL to support clinical reasoning, where errors can have significant consequences, with gains in clinical judgment improving by 30%–45%. Teacher education programs found authentic, scenario-based PBL particularly effective, while TVET and Industrial Technology fields favored PBL due to its emphasis on design, fabrication, and practical synthesis

### 3.16 Most Effective Models and Strategies

Synthesizing evidence across the reviewed studies, SSI-based PBL, STEM-integrated PBL, and guided inquiry emerged as the most consistently effective models, especially when combined with Socratic questioning, analytical rubrics, and argumentation-based activities. These approaches balance cognitive challenge with support, making them well-suited for SUCs where student preparedness varies widely.

### 3.17 Summary of Objective 3

Overall, the findings demonstrate that the most effective PBL models are those that integrate authentic problem contexts with structured instructional supports. These insights address Research Question 3 by highlighting the specific pedagogical configurations that most strongly promote critical thinking in SUCs.

## 4. Conclusion

This systematic review highlights both the substantial progress and the enduring challenges surrounding the adoption of Problem-Based Learning (PBL) to develop critical thinking in State Universities and Colleges (SUCs). While the evidence base demonstrates consistently positive outcomes—showing that PBL enhances students’ analytical, evaluative, and integrative reasoning—implementation across institutions remains uneven. The review reveals that although many SUCs are beginning to incorporate PBL into their instructional systems, sustained, high-fidelity implementation is still limited, particularly in programs constrained by large class sizes, insufficient resources, and faculty unpreparedness.

At the same time, global and local models illustrate what is achievable when PBL is grounded in strong pedagogical design, structured facilitation, and contextually relevant problem scenarios. Effective implementations across disciplines, especially in STEM, health sciences, and teacher education demonstrated meaningful cognitive gains emerged when students are provided with authentic problems, collaborative learning environments, and continuous opportunities for reflection. Yet the persistence of short-duration interventions, inconsistent assessment practices, and a lack of institutional support systems continues to hinder the realization of PBL’s full transformative potential.

The findings point to a clear agenda for strengthening practice: SUCs must invest in systematic faculty training, integrate PBL into curriculum structures rather than isolated activities, align assessment systems with higher-order reasoning goals, and ensure contextualization of problems to local realities. Such measures, supported by rigorous monitoring and research, offer a practical pathway for enhancing the quality of higher education and equipping learners with the critical thinking skills required in complex and rapidly changing professional landscapes. The time for fragmented or experimental adoption has passed—what SUCs need now is sustained, evidence-driven commitment to embed PBL as a cornerstone of student-centered, inquiry-driven learning that prepares graduates for meaningful engagement in society.

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