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Problem-based learning in physical education and sport: a systematic review of implementation approaches, learning outcomes, and contextual determinants

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ABSTRACT

Problem-Based Learning (PBL) is a student-centred strategy with the potential to foster higher-order thinking and active engagement, yet its use in physical education (PE) and sport remains limited and fragmented across contexts. This systematic review of literature comprehensively analyzes primary research works to establish how PBL has been implemented in PE and sport-related educational settings, what learning results it yields, and which environmental factors influence its use. PRISMA 2020 was the review guideline, and it was based on a formal Scopus search which initially identified 214 records. After the exclusion of news, reviews and non-English documents, screening for title and abstract, assessment of full texts against the set criteria, a total of 12 studies published from 2021 to 2025 were included in the review. The thematic analysis showed that PBL is being implemented through various modes, some of which include technology-backed tactical simulations and teacher-training projects. The principal results of PBL are the enhancement of motor skills, tactical decision-making, critical thinking, teamwork, and engagement. However, the realization of PBL results was found to be dependent on readiness of teachers, time, and curriculum support. The article develops sport pedagogy by charting PBL implementation and outcomes, giving practical orientation for teachers and coaches, and urging for larger, longer-term and rigorously designed studies.



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Introduction

Education systems today focus more and more on developing learners' capability to think critically, work collaboratively, communicate effectively, and solve problems independently, in addition to the memorization of content (Ito, 2017; Mitchell et al., 2024). Therefore, active and learner-centred pedagogies have gained prominence as they change the role of students from passive recipients to active knowledge constructors (Riyanto, 2019; Chen et al., 2023).

In this range of pedagogies, PBL holds a significant position as it challenges students with authentic problems that are loosely structured and require the modes of inquiry, negotiation, and knowledge integration across different subject areas. As education systems around the world are modified to put a greater focus on skills that are transferable, the question of the role of such pedagogies when it comes to physical education and

sports, which are characterised by body movement and physical engagement, becomes a matter of focus and concern.

PE and sport stand apart from the rest in this reform as they blend cognitive, motor and social learning in lively, interactive settings. However, PE teaching methods have been centered around the teacher leading the class, and giving instructions in the command style with students just copying the set movements without being given chances to make independent decisions (Aguilera et al., 2020; Muarifin, 2022). These kinds of instructions might lead to technical reproduction, but they largely ignore the students' active role, tactical understanding, and creativity. Issues still occurring in PE classes are students' limited attention, teacher being the dominant presence, and students being passive, and such conditions among other things have led teachers to look for more attractive and mentally challenging ways of teaching (Næss, 2021; Sotos-Martínez et al., 2023).

In line with this, a considerable number of studies have identified active methodologies in PE such as physically active learning, gamification, experiential learning, and movement-centred pedagogy (Bacon et al., 2021; Chalkley et al., 2023; Varman et al., 2023). On one hand, physically active learning initiatives have been demonstrated to increase physical activity and to support on-task behaviour as well as academic outcomes (Bacon et al., 2021; Morris et al., 2019), whereas gamification has motivated one of the groups of PE students (Sotos-Martínez et al., 2023). On the other hand, model-based teaching reviews have shown that pedagogical models can positively influence pupils' fitness levels, academic performance, and enjoyment (Elumalai et al., 2022). Evidence regarding professional and higher education settings is similar, highlighting that the integration of physical sports and experiential activities foster resilience, engagement, and applied competence (Malau et al., 2025; Ruegsegger et al., 2025) and how the choice of methodology creates different learning profiles (Anasagasti et al., 2023). In essence, these strands of evidence prove that it is the way PE is taught, not just what is taught, that leads to varied learning outcomes.

Pushing ahead with recent developments, the methodological repertoire has been further diversified by incorporating digital and analytic tools into PE and sport instruction. Flipped-classroom and deep-learning designs have been utilised to change the focus of class time to student-centred activity (Xing et al., 2025), mind-mapping and small-group strategies have been used to get students engaged (He et al., 2024), and immersive technologies such as metaverse have been looked into as new learning spaces (Chen et al., 2023). Classroom-based, physical forms of literacy promotion and healthy living behaviour provisions have also been made, sometimes employing design-based physical literacy and interdisciplinary assignments linking movement with academics (Romero-Martinez et al., 2025; Varman et al., 2025; Mashud, 2025; Rodríguez-Martín et al., 2022). In this growing arena, PBL is often cited as the flagship student-centred model, however, the specific manner in which it is implemented and its effects in movement contexts are patchily documented.

The enthusiasm and interest notwithstanding, PBL-specific evidence in PE and sports remains disjointed and scattered across different journals, study groups, and education levels. Isolated research reported promising findings but are seldom brought together in a way that would enable teachers, teacher educators, and coaches to discern patterns of practice and outcome. Work related to experiential and inquiry-based learning as well as problem-centred designs is already quite positive (Varman et al., 2023; Hong et al., 2023), but these reports rarely make links to the PE pedagogy literature. Without an integrative review, the field is left without a clear picture of how PBL is enacted in movement settings or of the outcomes it reliably produces.

Second, there is also a methodological and theoretical gap. Studies of PBL in PE are very different with respect to their design and normally use small samples, short intervention times, and single-site implementations, which significantly limit the generalizability of their findings. Besides the implementation of teacher-level factors on the use of active pedagogies are reported inconsistently (Daly-Smith et al., 2020; Walker et al., 2021). Teachers' capacity to enact student-centred methods varies widely with training, resources, and curricular support, according to cross-national evidence (Daly-Smith et al., 2021; Tomura et al., 2024). So we have know that the field not only lacks an empirical synthesis but also a critical evaluation of the conditions under which PBL succeeds or fails.

The importance of filling these gaps is even greater considering that the role of PE and sport to prepare students for the complex demands of the real world is expected to increase. Problem solving and teamwork are now considered main educational outcomes and PE is increasingly seen as a place where these can be developed alongside motor skills (Purnomo et al., 2024; Riyanto, 2019).

Synthesising how PBL contributes to these outcomes within PE and sport is both timely and necessary to guide evidence-based pedagogy. To fill the gaps identified above, this systematic literature review seeks to investigate three key questions. First, by what forms and in what contexts is problem-based learning implemented? This question aims to map the wide array of problem-based solutions employed across PE and

sport settings. By documenting these approaches, the review offers a structured description of how a rather abstract pedagogical principle is turned into physically based practice at various educational levels.

Guided by this framework, and to address the gaps identified above, the review pursues three research questions: RQ1. How has problem-based learning been implemented in physical education and sport across different educational contexts?. RQ2. What are the effects of problem-based learning on students' motor, cognitive, affective, and social learning outcomes in physical education and sport?. RQ3. What contextual factors and implementation challenges shape the application of problem-based learning in physical education and sport?

Method

Since systematic literature review (SLR) is unarguably the most rigorous and transparent method of mapping, evaluating, and synthesizing the body of evidence available on a particular question. It also greatly minimizes the bias characteristic of narrative reviews. Following the logic of systematic review methods in social sciences, that it mainly focuses on explicit protocols and accountable decision-making, the decision of the whole strategy was informed by it. The identification, screening, eligibility, and inclusion steps were guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) statement (Page et al., 2021), selected because of its explicitness, its correspondence with recent editorial expectations in sport pedagogy, and its capability of making every selection decision traceable through a flowchart and a narrative.

The structured Boolean search string was formulated in such a way to identify studies at the intersection of problem-based learning and physical education or sport. The string combined the idea of problem-based learning with the concept of the education context and concepts related to learning, by applying these terms in the title, abstract, and keywords fields. Variants of terms were captured by truncation, and Boolean operators were used for combining terms. Below is the final search string.

("problem-based learning" OR "problem-based learning" OR PBL OR "problem-oriented learning" OR "problem-oriented learning" OR "inquiry-based problem solving") AND ("physical education" OR "physical education and sport" OR "physical education and sports" OR "sport education" OR "school sport" OR "physical activity" OR PE OR PETE))

Field codes restricted matching to the TITLE-ABS-KEY index. The search was limited to peer-reviewed journal articles written in English. No geographic restriction was applied, so as to be able to capture the international character of the evidence base.

Scopus was chosen as the principal and authoritative source of information thanks to its comprehensive multidisciplinary coverage and rigorous indexing of sport pedagogy, education, and sport science journals. Besides these advantages, it also offers structured metadata that facilitates reproducible querying and export. The search was conducted on a single day to ensure a stable snapshot of the literature. The entire set of retrieved records, along with full bibliographic metadata, was exported for screening purposes. Restriction to a single top-quality database was a considered decision aimed at ensuring metadata consistency and avoiding deduplication artefacts that emerge when heterogeneous sources are merged; the repercussions of this decision are acknowledged in the limitations section. The search was conducted in Scopus, selected for its broad multidisciplinary coverage of sport pedagogy, education, and sport-science journals, its rigorous indexing, and its structured, exportable metadata, which together support reproducible querying and minimise the deduplication artefacts that arise when heterogeneous sources are merged. We acknowledge that no single database is exhaustive for an interdisciplinary field such as sport pedagogy, and that relevant studies indexed only in Web of Science, ERIC, SPORTDiscus, or PubMed may not have been captured. This single-source decision therefore privileges metadata consistency and reproducibility over maximal coverage; the resulting coverage bias is registered as a primary limitation and is reflected in the deliberately cautious framing of our conclusions.

In order to determine eligibility for inclusion in the review, a PICOS frame was used and it served as a basis for creating an inclusion and exclusion matrix. The population included learners or trainees in physical education, sport, or sport-related education across educational levels. The intervention or phenomenon of interest was problem-based learning, including closely related project-based and problem-centred variants applied as a teaching approach. The comparison, where present, was any alternative or conventional instructional approach. The outcomes of interest were motor, cognitive, affective, or social learning outcomes, or documented implementation experiences. Eligible designs included experimental, quasi-experimental, qualitative, mixed-method, and analytical studies. Eligibility was restricted to peer-reviewed journal articles published in English to ensure consistent quality appraisal and reliable interpretation of methods and findings

by the review team. We recognise the tension between this criterion and the international character of the evidence base: because much PBL-in-PE scholarship is published in Indonesian, Chinese, Spanish, and Korean, the restriction may have systematically excluded relevant studies. This language bias is acknowledged as a limitation that constrains both the comprehensiveness and the transferability of the synthesis.

Table 1. Framework for PICOS Used in the Review

Parameter	Definition applied in this review
Population (P)	Learners or trainees in physical education, sport, or sport-related education across levels (school, university, vocational).
Intervention (I)	Problem-Based Learning and closely related problem-centred or project-based variants applied as a teaching or learning approach.
Comparison (C)	Conventional or alternative instruction (e.g., direct instruction, traditional methods), where reported; not required for inclusion.
Outcome (O)	Motor, cognitive, affective, or social learning outcomes, or documented implementation experiences and perceptions.
Study design (S)	Experimental, quasi-experimental, qualitative, mixed-method, or analytical empirical studies.

Table 2. Criteria for Inclusion/Exclusion

Criterion	Inclusion	Exclusion
Language	English	Non-English
Document type	Journal article	Conference paper, book chapter, editorial, note
Publication period	2021–2025	Before 2021
Subject area	Physical education, sport, sport-related education	Unrelated disciplines (e.g., clinical medicine, chemistry)
Focus	Problem-Based Learning as the studied approach	Tangential or incidental mention of problems
Outcome	Reports learning outcomes or implementation experience	No empirical learning outcome or experience
Accessibility	Full text available	Full text not retrievable

The process of study selection consisted of the sequence of three stages. First, the title and abstract of all documents retrieved were screened against the eligibility criteria to identify and exclude clearly non-relevant documents such as those coming from unrelated disciplines. Second, the full texts of potentially eligible papers were obtained and carefully examined against the inclusion and exclusion criteria. Third, papers which met all the requirements were retained for synthesis. Full texts that could not be found were listed as such. To keep an auditable trail, the decisions made at each stage were noted, and cases of ambiguity were resolved by referring to the full text one more time against the criteria set in advance, with the more conservative decision taken where uncertainty remained.

Methodological quality and relevance of each full text study were evaluated using FICO framework, which assesses 4 aspects: Focus, clear and right research aim; Information, enough and transparent methods and data; Context, relevant setting to PE and sport; Outcome, distinct and justifiable findings. The scores for each aspect went from 0 to 1 in increments of 0.5.

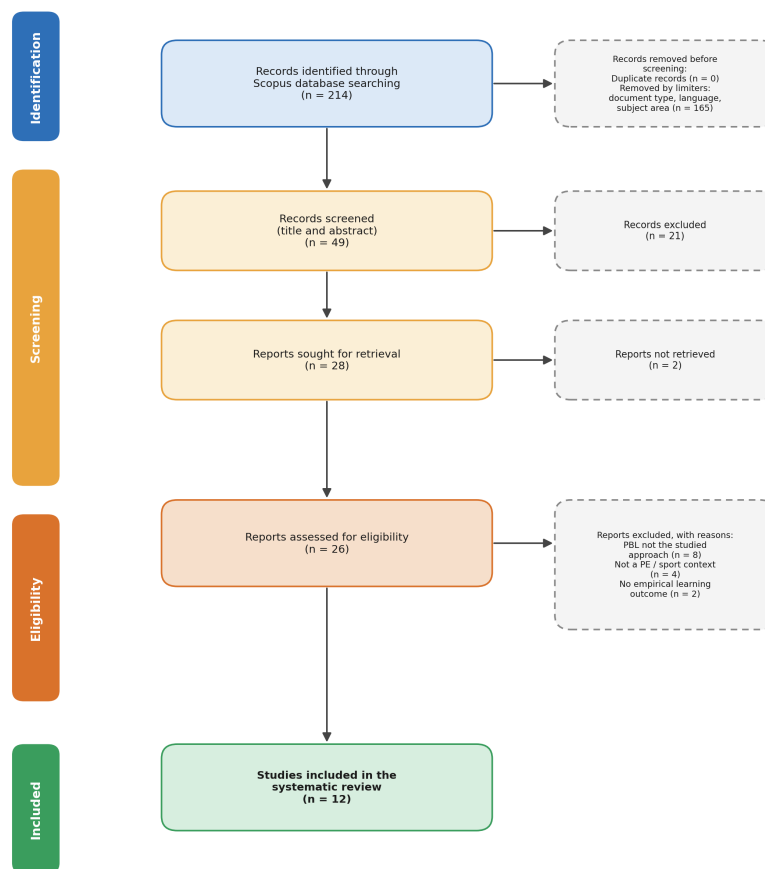
Each of the studies selected for inclusion was subjected to the standardized extraction template for consistency purposes. The information extracted included the author, year of publication, country where data was collected, study design, characteristics of the sample, type of problem-based intervention, outcome measures used, and main findings. Extraction was done based on the full texts, and the resulting table became the evidence basis for the descriptive and thematic syntheses presented in the results. In cases of multiple outcomes, all relevant ones were extracted to maintain the richness of the evidence.

Table 3. Summary of FICO Quality Appraisal for the Included Studies (Minimum=3.0/4.0)

Study	F	I	C	O	Total	Decision
Jia et al. (2024)	1.0	1.0	1.0	1.0	4.0	Include
Santoso et al. (2024)	1.0	1.0	1.0	1.0	4.0	Include
Santoso & Santoso (2024)	1.0	1.0	1.0	1.0	4.0	Include
Lubis et al. (2022)	1.0	1.0	1.0	0.5	3.5	Include
Xia et al. (2025)	1.0	1.0	1.0	1.0	4.0	Include
Liu et al. (2023)	1.0	1.0	0.5	1.0	3.5	Include
Ryan (2021)	1.0	0.5	1.0	0.5	3.0	Include
Yáñez-Sepúlveda et al. (2023)	1.0	1.0	0.5	1.0	3.5	Include
Purnomo et al. (2024)	1.0	0.5	1.0	1.0	3.5	Include
Jang (2023)	1.0	1.0	0.5	1.0	3.5	Include
Mederer-Hengstl et al. (2024)	1.0	1.0	0.5	1.0	3.5	Include
Dupri et al. (2024)	1.0	1.0	1.0	0.5	3.5	Include

Note. F = Focus; I = Information; C = Context; O = Outcome. Each dimension scored 0–1.0; inclusion threshold = 3.0/4.0.

Narrative synthesis was complemented by bibliometric mapping across the included studies. The temporal publication trend was illustrated by the distribution of publications over time, while the geographical spread of the literature was charted to delineate how the evidence assembles internationally. In addition, a keyword co-occurrence map aggregated the author-given and infrequent but indicative keywords across the literature to identify key thematic clusters. This analysis serves to contextualize rather than substitute the thematic analysis, and the corresponding visuals are presented as Figures 2 to 4.



Adapted from Page et al. (2021), PRISMA 2020 statement. BMJ, 372, n71.

Figure 1. PRISMA 2020 flow diagram of the study selection process (adapted from Page et al., 2021).

Rather than statistical meta-analysis that requires homogeneity of designs and outcomes, thematic synthesis method was used. Data from each paper were first analysed in such a way as to develop codes that were then categorised into descriptive themes and finally into analytical themes that correspond to the three research questions. To ensure that the interpretations remained faithful to original sources, themes were continuously compared to the source texts.

Reporting for the review was done in accordance with PRISMA 2020 checklist (Page et al., 2021). The figure illustrating the flow of records through identification, screening, eligibility, and inclusion is provided as Figure 1, and the numerical data presented in the abstract, methods, and results sections are consistent with the flow diagram. Verification of all bibliographic information of the finally included studies was done by checking against exported source metadata to maintain data integrity.

Results and Discussions

The Scopus search initially identified 214 records. Before screening, no duplicate records were detected within the single-database export, and 165 records were excluded through the application of document-type, language, and subject-area limiters, leaving 49 records for screening. Title and abstract screening against the eligibility criteria excluded 21 records that did not address problem-based learning within a physical education or sport context, including studies drawn from unrelated clinical and physical-science disciplines. The full texts of the remaining 28 reports were sought, of which 2 could not be retrieved. The 26 reports assessed for eligibility were appraised against the inclusion and exclusion criteria and the FICO quality threshold. Fourteen reports were excluded with reasons: 8 did not treat problem-based learning as the studied approach, 4 were not situated in a physical education or sport context, and 2 reported no empirical learning outcome. This process yielded 12 studies for inclusion in the synthesis. The complete flow is depicted in Figure 1, and the numerical values are consistent across the abstract, methods, and results.

The 12 included studies were published between 2021 and 2025, with a clear concentration in 2024 (six studies), reflecting rapidly intensifying scholarly interest in problem-based learning within physical education and sport. Table 4 summarises the characteristics of each study, including full titles, authorship, country, method, and key findings, while Table 5 classifies the corpus by research design, thematic focus, and reported outcome. The temporal distribution is visualised in Figure 2, the geographic distribution in Figure 3, and the dominant thematic clusters in Figure 4.

Geographically, the evidence base is led by Indonesia, which contributed five of the 12 studies, followed by China with three, and single contributions from Canada, Chile, South Korea, and Spain. This distribution indicates that problem-based learning in physical education has become a particularly active area of inquiry in Indonesian and Chinese sport pedagogy, while remaining geographically uneven across the wider field. Methodologically, the corpus comprised eight experimental or quasi-experimental studies, two survey or associative studies, and two qualitative studies, indicating a predominance of outcome-focused designs alongside a smaller body of experience-focused inquiry.

Thematically, the corpus clustered around the implementation of problem-based learning for motor and sport-skill development, its effects on cognitive outcomes such as tactical decision-making and critical thinking, its influence on social competencies such as teamwork, and its use in teacher training and curriculum policy. The prominence of these clusters, depicted in Figure 4, mirrors the three research questions and structures the thematic synthesis that follows.

Table 4. Characteristics of the Included Studies (n = 12)

Title	Author(s) & Year	Country	Method	Key findings
Screen-based Simulation Supporting Problem-based Learning to Improve Football Tactics	Jia et al. (2024)	China	Quasi-experiment (n = 79)	PBL combined with screen-based simulation significantly improved undergraduate football tactical decision-making, tactical skills, and student engagement relative to traditional teaching;

Title	Author(s) & Year	Country	Method	Key findings
How do the Learning Models of Teaching Game for Understanding and Problem-Based Learning Influence Fundamental Football Skills in Physical Education? Conducting an Analysis in the Elementary School Context	Santoso et al. (2024)	Indonesia	Quasi-experiment (n = 46)	<p>the experimental group outperformed controls on all measures ($p < .01$).</p> <p>Both PBL and Teaching Game for Understanding significantly improved elementary students' fundamental football skills ($p < .001$); a significant difference favoured one model over the other, confirming that both active models are effective for skill development.</p>
Case study: problem-based learning model for soccer basic movement skills and learning activity	Santoso & Santoso (2024)	Indonesia	Pre-experiment, one-group pretest-posttest (n = 24)	<p>PBL significantly enhanced both basic soccer movement skills (mean rising from 99.08 to 109.04) and learning activity (3.08 to 4.38), with paired t-tests confirming significant gains, supporting PBL as a potent strategy for skill and engagement.</p>
Do problem-based learning and flipped classroom models integrated with Android applications based on biomechanical analysis enhance the learning outcomes of Pencak Silat?	Lubis et al. (2022)	Indonesia	Experiment, Rasch analysis (n = 76)	<p>PBL integrated with a biomechanics-based Android application significantly improved pencak silat learning outcomes ($p \leq .05$); the design proved a reliable and valid formula for enhancing student mastery of single artistic movements.</p>
Fostering teamwork skills through PBL volleyball courses: A social psychological study of Chinese vocational college students	Xia et al. (2025)	China	Quasi-experiment (n = 81)	<p>Over a 12-week PBL volleyball curriculum, the experimental group showed significantly greater gains across cognitive, emotional, and behavioural dimensions of teamwork than controls, underscoring PBL's value for cultivating</p>

Title	Author(s) & Year	Country	Method	Key findings
Effect of the problem-based learning method on student electroencephalograms and microcirculatory blood perfusion in the teaching of sports physiology	Liu et al. (2023)	China	Randomized experiment (n = 20)	psychosocial competencies. PBL produced significantly higher quiz scores than traditional teaching in sports physiology and was accompanied by measurable changes in EEG alpha/beta power, indicating greater active cognitive engagement during learning.
Problem-based learning opportunities within Ontario (Canada) elementary health and physical education	Ryan (2021)	Canada	Qualitative content analysis	Analysis of the 2019 Ontario Health and Physical Education curriculum found that it actively guides educators toward a problem-based, learning-by-doing pedagogy that increases learner awareness and supports constructivist, self-directed inquiry.
Project-Based Learning as a Strategy in Physical Education Teacher Training: Creating A Cultural Route Promoting Active Commuting	Yáñez-Sepúlveda et al. (2023)	Chile	Qualitative, narrated reflection (n = 53)	Pre-service PE teachers designing cultural active-commuting routes around a driving question reported meaningful learning; PBL effectively linked subject content with students' motivations and interests in initial teacher training.
Enhancing Problem-Solving Skills Through Physical Education Learning: A Comprehensive Analysis	Purnomo et al. (2024)	Indonesia	Associative/quantitative (n = 50)	Physical education was found to improve problem-solving skills, with problem-solving confidence, approach-avoidance style, and personal control forming a coherent factor; PBL was concluded to enhance high-school students' learning outcomes.
Analysis of the Problem-Based Learning Model's Application for the	Jang (2023)	South Korea	Survey, importance-performance analysis (n = 331)	University sports majors valued PBL for problem analysis,

Title	Author(s) & Year	Country	Method	Key findings
Sustainable Development of Sports Education				knowledge acquisition, and team intimacy; importance-performance analysis identified priorities such as self-directed planning and creative communication for sustainable sports education.
Evaluation of Problem-Based Learning Experiences Addressing Health Promotion in the Fourth Grade of Primary School	Mederer-Hengstl et al. (2024)	Spain	Quasi-experiment, four-year (n = 213)	PBL health-promotion projects produced significantly greater gains in intervention than control groups (6.94 vs 3.62 points), developing skills such as information search, synthesis, decision-making, and teamwork while broadening knowledge of healthy habits. PBL significantly improved high-school students' critical thinking skills and outperformed Discovery Learning (p < .001); female students developed critical thinking more strongly than male students.
Critical thinking skills to physical education: the influence of learning models and gender	Dupri et al. (2024)	Indonesia	Quasi-experiment, nonequivalent control group (n = 68)	

Table 5. Thematic and Methodological Classification of the Included Studies

Author(s) & Year	Country	Research design	Theme / focus	Reported outcome
Jia et al. (2024)	China	Quasi-experiment	Technology-supported PBL (football tactics)	↑ Tactical decision-making & engagement
Santoso et al. (2024)	Indonesia	Quasi-experiment	PBL vs TGfU (football skills)	↑ Fundamental motor skills
Santoso & Santoso (2024)	Indonesia	Pre-experiment	PBL & soccer movement skills	↑ Skills & learning activity
Lubis et al. (2022)	Indonesia	Experiment (Rasch)	PBL + flipped + app (pencak silat)	↑ Learning outcomes

Author(s) & Year	Country	Research design	Theme / focus	Reported outcome
Xia et al. (2025)	China	Quasi-experiment	PBL & teamwork (volleyball)	↑ Teamwork (cognitive/emotional/behavioural)
Liu et al. (2023)	China	Randomized experiment	PBL & cognition (sports physiology)	↑ Achievement; ↑ cognitive engagement
Ryan (2021)	Canada	Qualitative analysis	PBL in H&PE curriculum policy	Curriculum endorses PBL pedagogy
Yáñez-Sepúlveda et al. (2023)	Chile	Qualitative	PBL in PE teacher training	Meaningful, motivated learning
Purnomo et al. (2024)	Indonesia	Associative/quantitative	PBL & problem-solving skills	↑ Problem-solving skills
Jang (2023)	South Korea	Survey (IPA)	PBL for sustainable sports education	Perceived value; priority attributes
Mederer-Hengstl et al. (2024)	Spain	Quasi-experiment	PBL & health promotion	↑ Knowledge & transversal skills
Dupri et al. (2024)	Indonesia	Quasi-experiment	PBL & critical thinking (gender)	↑ Critical thinking (gendered)

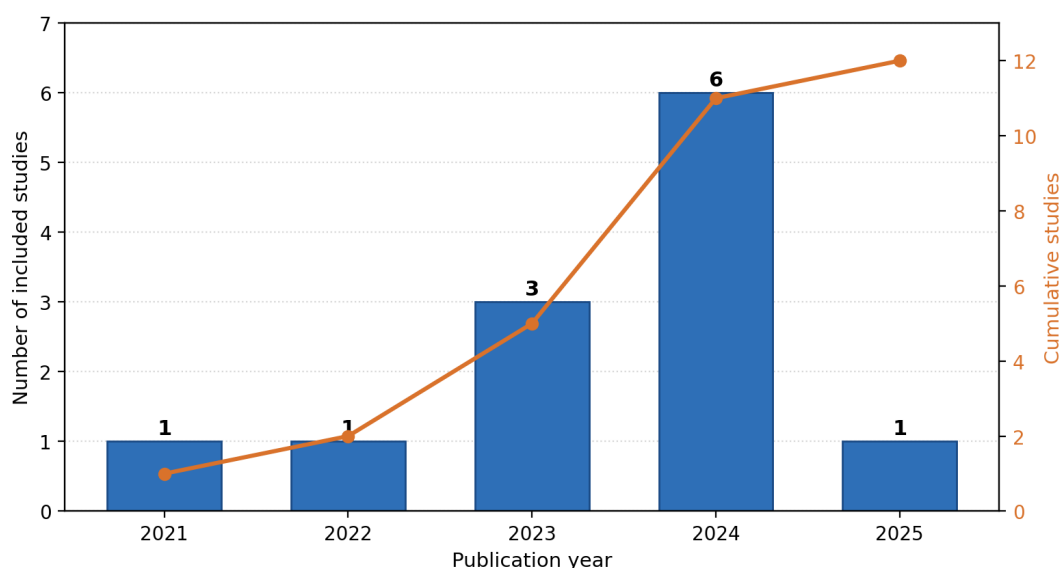


Figure 2. Annual distribution of the 12 included studies (2021–2025).

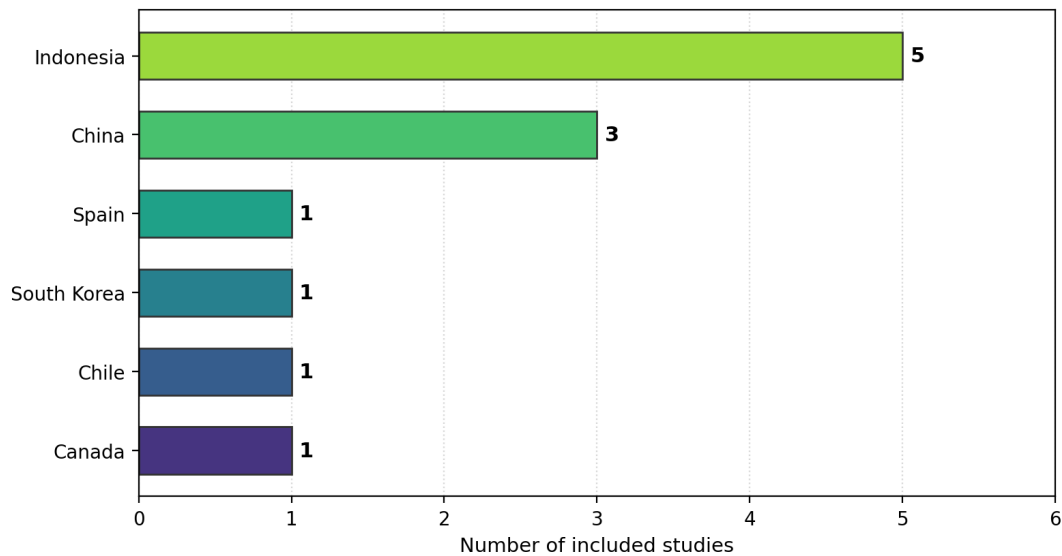


Figure 3. Geographic distribution of the included studies by country.

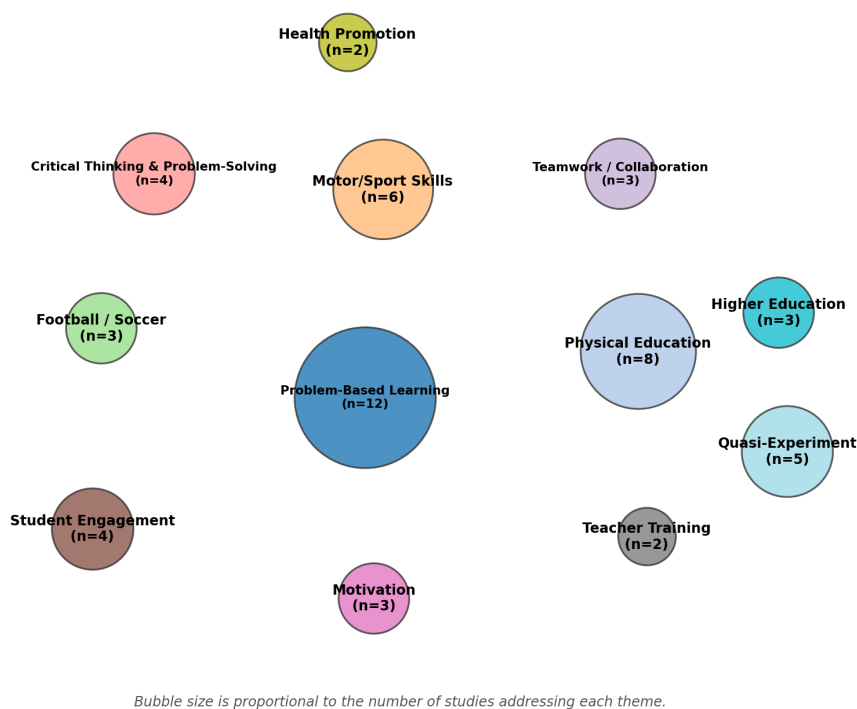


Figure 4. Thematic clusters and keyword co-occurrence across the included studies.

Thematic Synthesis

Findings for RQ1: Forms of Problem-Based Learning Implementation

The first research question concerned how problem-based learning has been implemented across physical education and sport settings. The synthesis revealed a marked diversity of formats, from technology-enhanced designs to curriculum-level pedagogy. A prominent cluster embedded PBL within motor-skill instruction, using authentic movement problems to develop fundamental football skills (Santoso et al., 2024; Santoso & Santoso, 2024), volleyball competencies (Xia et al., 2025), and martial-arts performance in pencak silat (Lubis et al., 2022). These designs retained the embodied, motor-rich character of physical education while embedding inquiry, analysis, and problem solving into practice.

A second cluster integrated PBL with digital and analytic tools to deepen tactical and conceptual understanding. Screen-based simulation was combined with PBL to scaffold the identification and analysis of football tactical problems (Jia et al., 2024), while a biomechanics-based Android application supported problem-based mastery of complex movement sequences (Lubis et al., 2022). At the level of theory-oriented instruction,

PBL was applied to the teaching of sports physiology, where it was associated with measurable changes in cognitive engagement (Liu et al., 2023). These cases demonstrate that PBL in PE is not confined to the gymnasium but extends to laboratory and screen-based environments.

A third cluster situated PBL within teacher training, curriculum policy, and higher education. Pre-service PE teachers enacted PBL by designing cultural active-commuting routes around a driving question (Yáñez-Sepúlveda et al., 2023), curriculum analysis revealed explicit policy endorsement of problem-based pedagogy in elementary health and physical education (Ryan, 2021), and university sports programmes applied PBL as a model for sustainable sports education (Jang, 2023). Further applications addressed health promotion in primary schooling (Mederer-Hengstl et al., 2024) and the cultivation of critical thinking and problem-solving in secondary PE (Dupri et al., 2024; Purnomo et al., 2024). Across these formats, the unifying feature was the use of authentic problems to drive active, learner-centred engagement.

Across these clusters, implementations also varied in educational level and duration. The corpus spanned elementary schooling (Santoso et al., 2024; Santoso & Santoso, 2024), secondary education (Dupri et al., 2024; Purnomo et al., 2024), vocational and undergraduate programmes (Xia et al., 2025; Jia et al., 2024), and initial teacher education (Yáñez-Sepúlveda et al., 2023), while one study analysed system-level curriculum policy (Ryan, 2021). Intervention length ranged from short instructional units to sustained programmes lasting several weeks or, in the case of health-promotion projects, multiple academic years (Mederer-Hengstl et al., 2024). This variation indicates that problem-based learning is not a fixed protocol but a flexible architecture that practitioners calibrate to learners' maturity, the resources available, and the competencies prioritised. The common thread uniting these diverse formats is the presence of an authentic, ill-structured problem, an active process of inquiry and negotiation, and a structured opportunity for reflection, the features most consistently associated with the positive outcomes reported across the corpus.

Findings for RQ2: Effects on Learning Outcomes

Because the primary studies are predominantly small, single-site, and short-term, the effects reported below should be read as associations observed under largely favourable conditions rather than as established causal magnitudes. The second research question examined the effects of problem-based learning on learning outcomes. With respect to motor and skill-based outcomes, the experimental evidence was consistently positive. PBL significantly improved fundamental football skills among elementary students (Santoso et al., 2024), basic soccer movement skills and learning activity (Santoso & Santoso, 2024), and pencak silat learning outcomes when integrated with biomechanical feedback (Lubis et al., 2022). Tactical competence also improved, with PBL combined with screen-based simulation enhancing football tactical decision-making and tactical skills relative to traditional instruction (Jia et al., 2024).

Cognitive and affective outcomes were likewise well represented. PBL significantly enhanced critical thinking skills, outperforming Discovery Learning in secondary PE (Dupri et al., 2024), and was associated with improved problem-solving skills among high-school students (Purnomo et al., 2024). In the teaching of sports physiology, PBL produced higher achievement alongside neural indices of greater cognitive engagement (Liu et al., 2023). Beyond cognition, PBL fostered social competencies: a 12-week PBL volleyball curriculum significantly improved cognitive, emotional, and behavioural dimensions of teamwork (Xia et al., 2025), and PBL health-promotion projects developed transversal skills such as information search, synthesis, decision-making, and collaboration (Mederer-Hengstl et al., 2024).

A consistent nuance across the affective and social findings concerned the conditions and learners involved. Critical-thinking gains were gender-differentiated, with female students developing the skill more strongly than male peers (Dupri et al., 2024). Perceptual evidence from university sports majors indicated that the value of PBL was concentrated in attributes such as self-directed planning, creative communication, and team cohesion, with some attributes rated high in importance but lower in performance (Jang, 2023). Qualitative accounts emphasised that meaningful learning emerged when problems were authentic and connected to students' motivations and interests (Yáñez-Sepúlveda et al., 2023). These patterns indicate that, although PBL reliably benefits a broad range of outcomes, the magnitude and distribution of effects are contingent on task design, learner characteristics, and the authenticity of the problem.

Considered as a whole, the pattern of effects suggests a hierarchy of evidential strength. The most robust evidence concerns motor-skill and tactical gains demonstrated through controlled comparisons with conventional instruction (Jia et al., 2024; Santoso et al., 2024; Lubis et al., 2022), followed by cognitive and social gains evidenced through quasi-experimental and pre-post designs (Dupri et al., 2024; Xia et al., 2025; Mederer-Hengstl et al., 2024), and finally by perceptual and qualitative evidence drawn from surveys and reflective accounts (Jang, 2023; Yáñez-Sepúlveda et al., 2023; Ryan, 2021). Although all three strands point in the same favourable direction, the convergence of experimental and experiential evidence strengthens

confidence that the benefits are not merely artefacts of novelty or self-report bias. At the same time, the reliance on short interventions means that the durability of these gains over time remains largely untested, an important qualification when translating the evidence into sustained curricular practice.

Findings for RQ3: Contextual Factors and Implementation Challenges

The third research question addressed the contextual factors and implementation challenges shaping problem-based learning in physical education and sport. A recurring contextual driver was the recognition, in both research and policy, that traditional teacher-centred instruction produces passivity and limited engagement, motivating the adoption of PBL as a corrective (Santoso & Santoso, 2024; Ryan, 2021). Where curriculum policy explicitly endorsed problem-based pedagogy, as in the Ontario health and physical education framework, the conditions for systemic adoption were more favourable (Ryan, 2021), illustrating the enabling role of curricular alignment.

Implementation also depended on teacher capability and resources. The effectiveness of PBL was repeatedly tied to teachers' ability to select appropriate strategies and to design authentic problems, a demanding pedagogical competence that initial teacher training must cultivate (Yáñez-Sepúlveda et al., 2023; Santoso & Santoso, 2024). Technology-supported implementations required additional infrastructure and design expertise, such as simulation platforms and application development, which may not be uniformly available (Jia et al., 2024; Lubis et al., 2022). In higher education, the perceived gap between the importance and the performance of certain PBL attributes signalled that institutional support and structured facilitation are necessary for the model to function as intended (Jang, 2023).

Methodologically, the corpus was characterised by modest sample sizes, predominantly single-site designs, and relatively short intervention windows, with quasi-experimental designs prevailing over randomised or longitudinal designs. Several studies relied on self-report instruments and perception questionnaires, which, while informative about experience and acceptability, provide weaker evidence of causal effect. The concentration of evidence in a small number of national contexts further constrains transferability. Collectively, these characteristics indicate that, while the direction of effects is encouraging, the methodological foundation of the field remains developmental and would benefit from greater rigour, scale, and contextual diversity.

Comparative and Critical Analysis

Beyond their nonequivalent groups, the dominant quasi-experimental designs are vulnerable to several specific threats to internal validity that temper confidence in the reported effects. Selection bias is plausible where intact classes were assigned non-randomly; maturation and history threats are relevant in interventions spanning weeks to academic years; and testing effects may inflate gains where the same instrument served as both pre- and post-test. Novelty or Hawthorne effects are difficult to exclude when an innovative pedagogy is compared with routine instruction, and the predominance of single-site designs limits external validity. These threats do not negate the consistently favourable direction of effects, but they imply that the reported magnitude of benefit is likely an upper-bound estimate obtained under near-optimal conditions.

Comparing methodological approaches across the corpus reveals a field weighted toward outcome evaluation. Quasi-experimental designs dominated and produced the strongest evidence of motor, cognitive, and social benefit, yet their nonequivalent control groups and single-site samples limit causal inference. The single randomised experiment, conducted in sports physiology, offered stronger internal validity but with a very small sample (Liu et al., 2023). Qualitative and analytical designs illuminated the lived processes of PBL and the policy structures that enable it (Yáñez-Sepúlveda et al., 2023; Ryan, 2021), but were not designed to quantify effect, while survey-based importance-performance analysis captured perceived value without establishing learning gains (Jang, 2023).

A notable methodological feature is the increasing integration of technology and analytic tools into PBL designs over time, including screen-based simulation, biomechanical applications, and neurophysiological measurement (Jia et al., 2024; Lubis et al., 2022; Liu et al., 2023). This evolution signals a maturing methodological imagination, yet underused designs remain conspicuous: randomised controlled trials, longitudinal follow-ups, and multi-site collaborations are largely absent. The reliance on locally developed instruments and self-report measures, although appropriate for capturing acceptability, should increasingly be complemented by validated, objective performance measures to substantiate claims of effectiveness and to enable cumulative synthesis.

Sample sizes across the corpus ranged from very small cohorts of around twenty participants in tightly controlled or neurophysiological studies to surveys exceeding three hundred respondents, with most experimental studies operating with samples between forty and two hundred. This dispersion reflects the dual character of the field, in which outcome-focused studies prioritise statistical comparison while experience-focused studies prioritise depth of insight. Measurement instruments were similarly heterogeneous,

encompassing skill and achievement tests, validated teamwork and problem-solving scales, neurophysiological indices, observation protocols, and reflective artefacts. The predominance of locally developed or context-specific instruments, rather than uniformly validated measures, complicates cross-study comparison and aggregation. Strengthening measurement through shared, psychometrically robust instruments would materially enhance the cumulative value of future research and would enable the meta-analytic synthesis that the present heterogeneity precludes.

Discussion

Interpreted collectively, the findings indicate that problem-based learning functions in physical education and sport as a coherent, student-centred pedagogy capable of aligning motor competence with cognitive and social development. The consistency of positive outcomes across diverse contexts, from elementary football lessons to university sports physiology, suggests that the active, inquiry-driven structure of PBL, rather than any single content domain, drives its benefits. This interpretation is consistent with broader evidence that active and physically active methodologies reposition learners as constructors of knowledge and enhance engagement in PE settings (Bacon et al., 2021; Chalkley et al., 2023), and with reviews indicating that pedagogical models improve fitness, achievement, and enjoyment (Elumalai et al., 2022).

From a motivational standpoint, the findings align with theories emphasising autonomy, competence, and relatedness as drivers of engagement. The authentic problems and tangible products characteristic of PBL afford learners greater autonomy, the progressive mastery of problem tasks supports perceptions of competence, and the collaborative structure cultivates relatedness, offering a parsimonious explanation for the consistent gains in engagement and teamwork observed across the corpus (Jia et al., 2024; Xia et al., 2025). This reading resonates with evidence that gamified and feedback-rich environments enhance motivation in physical education and higher education (Sotos-Martínez et al., 2023; Armengol et al., 2023), and clarifies why PBL appears effective across varied content: its mechanism resides in the psychological conditions the pedagogy establishes.

Theoretically, the synthesis extends constructivist and experiential learning frameworks into the embodied domain of physical education. The finding that authentic, driving-question projects mediate meaningful learning (Yáñez-Sepúlveda et al., 2023) and that curriculum policy can institutionalise problem-based pedagogy (Ryan, 2021) suggests that PBL operates not merely as an instructional technique but as an epistemological stance integrating knowing, doing, and reflecting. These observations challenge the persistence of command-style traditions in PE (Aguilera et al., 2020; Muarifin, 2022) and support a re-theorising of the discipline around active, learner-responsive pedagogy aligned with movement-centred priorities (Chalkley et al., 2023).

Practically, the evidence offers actionable guidance for teachers, teacher educators, and coaches. For teachers, the consistent motor, cognitive, and social benefits justify investment in problem-based designs, provided that authentic problems are well crafted and supported by adequate time and resources (Santoso & Santoso, 2024). For teacher educators, embedding PBL within initial preparation appears to strengthen pedagogical competence and meaningful learning (Yáñez-Sepúlveda et al., 2023), consistent with calls to redesign PE curricula around competence (Aguilera et al., 2020). For higher education and coaching, the model supports self-directed planning, creative communication, and teamwork, although institutional facilitation is required to convert perceived importance into realised performance (Jang, 2023; Næss, 2021).

Situating these findings relative to prior scholarship, the review corroborates analyses that map an expanding repertoire of active methodologies in physical education (Elumalai et al., 2022; Chalkley et al., 2023) while extending them with a focused synthesis of PBL specifically. Whereas earlier reviews treated PBL as one option among many, the present synthesis demonstrates its distinctive capacity to integrate movement, cognition, and collaboration around authentic problems. It also complements evidence on adjacent innovations such as flipped classrooms (Xing et al., 2025), mind mapping (He et al., 2024), and physical-literacy interventions (Romero-Martínez et al., 2025), positioning PBL within a broader movement toward meaningful, contextualised pedagogy.

Several contradictions and tensions warrant attention. First, the strong outcomes reported in controlled interventions (Jia et al., 2024; Dupri et al., 2024) contrast with the demanding conditions required for enactment, suggesting that effectiveness under optimal conditions may not generalise to typical classrooms with limited resources or teacher preparation (Daly-Smith et al., 2021; Walker et al., 2021). Second, the gendered pattern of critical-thinking gains, with female learners excelling (Dupri et al., 2024), complicates any uniform claim of benefit. Third, the gap between the perceived importance and the performance of key PBL attributes (Jang, 2023) indicates that espousing PBL is not equivalent to implementing it well, a tension echoed in the broader literature on adopting active pedagogies (Daly-Smith et al., 2020).

At least three research gaps emerge from the synthesis. First, the field lacks large-scale, longitudinal, and randomised evidence capable of establishing causal and durable effects of PBL on motor and learning outcomes. Second, the geographic concentration of evidence, particularly in Indonesian and Chinese school and university settings, leaves the transferability of findings to other systems and cultures largely untested. Third, the equity and inclusion dimensions of PBL, including its differential effects across gender, ability, and socio-economic context, remain insufficiently theorised and measured despite their importance for inclusive practice (Romero-Martínez et al., 2025; Varman et al., 2025).

For policymakers and curriculum designers, the synthesis carries a clear implication: the espousal of active pedagogy in curriculum documents must be matched by investment in the enabling conditions that allow problem-based learning to function. The Ontario case demonstrates how curriculum policy can legitimise and guide problem-based pedagogy (Ryan, 2021), yet policy endorsement alone is insufficient without sustained professional development, accessible exemplars, and assessment frameworks that accommodate problem-based work. Mandating PBL without addressing teacher preparation, time allocation, and technological infrastructure risks reproducing the gap between perceived importance and realised performance documented among practitioners (Jang, 2023; Daly-Smith et al., 2020). System-level support is therefore a precondition for translating policy aspiration into classroom reality, particularly in resource-constrained settings where the demands of designing authentic problems may otherwise deter adoption.

This review is subject to at least three limitations. First, reliance on a single database, Scopus, although chosen for metadata consistency, may have excluded relevant studies indexed elsewhere, introducing potential coverage bias. Second, the restriction to English-language journal articles may have omitted pertinent evidence published in other languages or formats, which is salient given the international character of the field (Tomura et al., 2024). Third, the heterogeneity of designs and outcomes precluded statistical meta-analysis, so the synthesis is interpretive and cannot quantify pooled effect sizes. These limitations should be weighed when interpreting the strength of the conclusions.

Building on these gaps and limitations, three concrete directions for future research are proposed. First, researchers should conduct multi-site, longitudinal, and where ethical randomised studies that combine objective performance measures with self-report to estimate the magnitude and durability of PBL effects in PE and sport. Second, comparative and cross-cultural studies should test the transferability of problem-based designs across educational systems, levels, and contexts, including higher education and coach education (Næss, 2021; Jang, 2023). Third, future work should integrate emerging technologies, such as simulation, immersive environments, and analytic feedback, to optimise problem design and to investigate the equity implications of PBL across gender, ability, and socio-economic context (Jia et al., 2024; Chen et al., 2023).

In direct response to the research questions, the synthesis supports the following summary answers. Regarding RQ1, problem-based learning is implemented in physical education and sport through three principal forms: motor- and sport-skill instruction built around authentic movement problems, technology-supported designs that scaffold tactical and conceptual understanding, and applications in teacher training, curriculum policy, and higher education. Regarding RQ2, PBL produces consistently positive motor, cognitive, affective, and social outcomes, including fundamental skills, tactical decision-making, critical thinking, problem-solving, teamwork, and engagement, although effects vary by task design and learner characteristics, notably gender. Regarding RQ3, implementation is shaped by curricular endorsement, teacher capability, time, and technological resources, while the methodological base remains dominated by small-scale, single-site, quasi-experimental designs.

Conclusions

This review offers the first focused synthesis of problem-based learning in physical education and sport, integrating evidence on how it is implemented, what it achieves, and the conditions under which it works. Across 12 studies, PBL was enacted through skill-based instruction, technology-supported designs, and applications in teacher training and curriculum policy, and was associated with improvements in motor skills, tactical decision-making, critical thinking, problem-solving, teamwork, and engagement, although the magnitude of benefit varied with task design, learner characteristics, and the authenticity of the problem. The central message for practice is therefore conditional rather than promotional: PBL is a powerful but resource-dependent pedagogy whose benefits materialize only when authentic problems are well designed and matched by adequate time, teacher preparation, and curricular and technological support. For teachers and coaches, this means investing in problem design and reflection rather than adopting PBL as a label; for teacher educators, embedding PBL early in initial preparation; and for policymakers, pairing any curricular endorsement with sustained professional development and infrastructure. Crucially, these recommendations are bounded by the review's own constraints.

Because the evidence derives from a single database and English-language sources and is concentrated in Indonesian and Chinese settings, PBL can be recommended with greatest confidence for South-East and East Asian school and university contexts and only provisionally elsewhere; and because the primary studies are predominantly small, single-site, and short-term, claims about the durability and scalability of effects remain tentative. The research priority is correspondingly clear: larger, longer-term, multi-site, and where ethical randomized studies, conducted across diverse educational systems and reported with validated, shared instruments, are needed to convert this promising but provisional evidence base into a secure foundation for practice and policy.

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