



**International Journal of Biology, Pharmacy
and Allied Sciences (IJBPAS)**

'A Bridge Between Laboratory and Reader'

www.ijbpas.com

PROBLEM-BASED LEARNING (PBL) AS COGNITIVE REFORM IN CLINICAL EDUCATION

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Received 16th March 2026; Revised 19th April 2026; Accepted 14th July 2026; Available online 1st Nov. 2026

<https://doi.org/10.31032/IJBPAS/2026/15.11.10610>

ABSTRACT

Problem-Based Learning (PBL) is increasingly recognized as a key pedagogical approach in clinical education due to its alignment with competency-based and practice-oriented curricula. This study looks at PBL as a cognitive reform that improves information integration, clinical reasoning, and higher-order thinking. PBL fosters self-directed, collaborative, and experiential learning through real-world clinical problem-solving, according to the study, which is based on a qualitative and quantitative evaluation of recent curricular reforms, including NCISM recommendations, and contemporary literature. By stimulating reasoning, memory integration, and adaptive decision-making, PBL engages across a range of cognitive domains, enabling students to convert theoretical information into useful clinical understanding. PBL promotes metacognitive growth and critical thinking by rethinking the position of the instructor as a facilitator. An extensive structure to strengthen clinical competence and meaningful learning is provided through the integration of PBL with understanding of perception and neurological processes.

Keywords: Neuroscience, Cognitive function, brain functioning, Problem-Based Learning

INTRODUCTION

Founded at McMaster University in 1969 and based on the educational theories of Dewey, Vygotsky, and others, Problem-Based Learning (PBL) has become a popular learner-centered teaching model in many academic fields. In order to support higher-order cognitive development and applied reasoning, PBL places a strong emphasis on self-directed learning through goal formulation and reflection, problem-solving through analysis of real-world case scenarios that promote critical thinking and communication skills, and cooperative teamwork through organized group discussions. The curricula that develop adaptive clinical competence—integrating knowledge, skills, and professional judgment in realistic settings—are becoming more prevalent in health professions education [1]. This agenda challenges conventional lecture-dominant models that may maximize content coverage but fall short on practice readiness by emphasizing higher-order cognition (interpretation, reasoning, problem solving), metacognition (self-monitoring, reflection), and transfer (applying concepts across clinical contexts). According to empirical research, PBL supports integrated clinical thinking while enhancing knowledge retention and creating a more intellectually stimulating learning environment [2]. In Ayurvedic

education, where numerous national assessments reveal a persisting gap between theoretical training and bedside competency, these factors are especially critical. Limited practice-oriented clinical learning and diminished graduate confidence are caused by limitations in patient flow, infrastructure, mentorship, and apprenticeship exposure [3-5]. Therefore, competency-oriented training, early clinical exposure, integrated learning, and evaluation models that measure performance rather than recall are becoming more and more important components of reform frameworks [6-8].

In light of this, the current narrative synthesis presents PBL as a cognitive reform approach for clinical education and assesses how evidence from Ayurvedic-specific initiatives and medical education might guide implementation in competency-based Ayurvedic training.

METHODS

A PRISMA-lite narrative synthesis was conducted using the peer-reviewed studies and policy/editorial analyses already compiled in the author's draft. Sources were selected because they directly addressed one or more of the following: (i) PBL mechanisms relevant to cognition (self-directed learning, metacognition, integration), (ii) comparative

outcomes versus didactic curricula using validated tools (MCQ taxonomy, OSCE, grades), (iii) learner-reported outcomes (motivation, communication, perceived understanding), and/or (iv) Ayurveda education reform needs and solutions (clinical exposure gaps, NCISM competency-based curriculum, hybrid PBL, digital case repositories/simulation). Data were extracted narratively on population, design type (controlled, quasi-experimental, retrospective audit, perception survey), outcome domains,

and key quantitative results (p-values, group differences) where available. Evidence was organized into thematic domains (MCQ reflecting cognitive reform: higher-order cognition and knowledge transfer, metacognition/self-directed learning, assessment alignment/OSCE/competency), and Ayurveda reform alignment (NCISM, practice exposure, digital platforms).

RESULTS

PBL and its basic features and functions

Table 1: PBL and its basic features and functions

S. No.	Feature	Description
1	Active Learning	PBL promotes independent and self-directed learning in which students take primary responsibility for their education. Learners build on prior knowledge and current understanding, while instructors provide guidance rather than direct instruction [9,24,25,26]
2	Group Collaboration	Learning occurs in small groups where students collaboratively analyze problems, exchange ideas, provide feedback, and develop solutions. This process strengthens teamwork, communication, critical thinking, and problem-solving skills through real and practical case engagement. [10].
3	Integration of Knowledge	PBL facilitates the application of theoretical concepts to real-world clinical scenarios, enabling students to translate classroom learning into practical understanding and reducing gaps between theory and practice.
4	Structured Tutorial Process	PBL commonly follows a structured “seven-jump” process, guiding learners from problem identification to collaborative analysis and solution development, fostering systematic, active, and curiosity-driven learning [11,32].
5	Curriculum Design Requirements	Effective PBL implementation requires curriculum restructuring, including increased emphasis on practical teaching, allocation of fixed learning timelines, appropriate learning resources, and enhanced teaching-learning tools compared to traditional lecture-based models [12,31].
6	Assessment and Evaluation	Conventional assessments may not fully capture PBL outcomes; however, learning gains are reflected in students’ ability to confidently apply knowledge, manage unfamiliar cases, and demonstrate practical competence [13].
7	Student-Centered Learning	Learners actively explore problems, seek information, and construct understanding, positioning students at the center of the learning process rather than as passive recipients of information [14].
8	Problem-Driven Learning	Learning is initiated by complex, open-ended problems rather than predefined content, encouraging inquiry and contextual reasoning [15].
9	Self-Directed Inquiry	Students independently research, analyze information, and formulate solutions instead of receiving direct answers, fostering lifelong learning skills [16,24].
10	Facilitator or Role of Teacher	Instructors function as facilitators who guide learning, provide feedback, and support reflection rather than delivering lectures, enabling students to navigate their own learning pathways [17,33].

PBL and higher-order cognition (problem solving, interpretation, integration)

PBL and case-based pedagogies consistently improve higher-order cognitive outcomes in medical education research. Adding CBL to undergraduate pathology dramatically enhanced higher-order cognition ($P < 0.0001$) but did not significantly alter lower-order recall ($P = 0.2048$), indicating a targeted effect on thinking rather than memorizing [18]. High student-reported increases in application and engagement as well as teacher-observed improvements in analytical/problem-solving skills were the results of multicomponent CBL that included case discussion and idea mapping [19]. Hybrid PBL modules were shown to rearrange learning around inquiry and clinical problems in Ayurvedic education, facilitating integrative reasoning even in lecture-dominant environments [20]. In preclinical Ayurveda, case-based methods have also been presented as ways to incorporate fundamental knowledge into real-world clinical situations [21].

Metacognition and self-directed learning

PBL's cognitive reform role is reinforced by evidence on self-directed and reflective learning. A two-month PBL course among Indian MBBS students increased self-directed and conceptual learning indicators and highlighted the importance of tutor facilitation

in strengthening higher-order learning processes [22]. In community medicine, PBL improved academic performance ($P < 0.001$) and demonstrated concordance between tutor and self-assessment ($r = 0.266$; $P = 0.05$), consistent with strengthened reflective self-evaluation. Foundational SDL literature supports PBL's association with self-regulated learning and lifelong learning capacities [9, 23, 24, 25, 26].

Comparative assessment evidence (MCQ/OSCE/grades) and cognitive depth

Comparative performance studies provide direct support for cognitive gains under PBL. In validated MCQ and OSCE comparisons, PBL students outperformed lecture-curriculum students in overall grades, higher cognitive knowledge (K2 MCQs), and OSCE performance, with statistically significant differences: Grade B proportion higher ($p = 0.035$), Grade C lower ($p = 0.001$), mean MCQ higher ($p = 0.001$), and mean OSCE higher ($p = 0.025$) (Zahid *et al.*, 2016). Moreover, the lecture group perceived K2 items as more difficult ($p = 0.001$), whereas PBL students did not, indicating better higher-order cognitive integration [27].

A retrospective audit of pharmacology assessments in India found statistically significant improvement after PBL introduction (e.g., IAE-1 vs IAE-3 $p = 0.020$;

ANOVA comparisons including PBL $p = 0.001$), alongside improved pass percentage, supporting PBL as a cognitively enriching adjunct to traditional teaching [28]. However, controlled evidence also indicates that PBL may yield similar short-term recall compared with lectures while enhancing motivation, understanding of patient problems, prescribing behaviour, and communication skills—suggesting that PBL’s advantage may be strongest in application/attitude domains rather than pure recall metrics [29].

Learner perceptions and communication/engagement outcomes

Perception-based evaluations of modified PBL in preclinical/paraclinical disciplines report notable perceived benefits. Across cohorts, 45–55.56% of students rated modified PBL more effective than traditional learning; 60–66.67% reported improved communication skills; and 52.5–66.67% reported improved understanding of course material [30]. Such findings align with PBL’s small-group facilitation and communication-intensive learning design.

Group Learning & Facilitation

Effective facilitation and structured small-group interaction are central to PBL’s cognitive impact, influencing reasoning depth, peer learning, and metacognitive regulation [31, 10, 32, 33].

Case-Based & Hybrid Models

Hybrid and case-based learning models function as pragmatic cognitive bridges in lecture-dominant curricula, preserving content coverage while activating analytical and clinical reasoning [18, 19, 34].

Technology-enabled learning

Digital extensions of PBL, including virtual patient simulations and structured case repositories, preserve problem-driven cognition while enhancing scalability and reflective practice [35, 36].

PBL alignment with Ayurveda educational reform needs

Ayurveda education reforms consistently identify inadequate bedside exposure and weak clinical skill training as core barriers to graduate competence [3-6]. Article [6] emphasize that Ayurveda education must progress beyond theory-dominant teaching toward practice-oriented competence, aligning with the classical sequence of learning (Adhiti → Bodha → Acharana → Pracharana) and advocating “critical inquiry” over ritualistic or rote approaches. National evidence suggests BAMS graduates experience insufficient exposure to emergency management, diagnostic interpretation, and Ayurveda-specific clinical procedures (including Panchakarma and

Kshara Sutra), contributing to low confidence in examination and decision-making [3].

The NCISM competency-based undergraduate Ayurveda curriculum represents a system-level shift toward learner-centred outcomes, workplace-based evaluation, early clinical exposure, integrated learning, and incorporation of PBL-compatible methods [7, 8]. This reform is conceptually congruent with PBL's cognitive goals: developing applied reasoning, reflective judgment, and performance-based competence. However, the effectiveness of such reforms is widely understood to depend on faculty capacity building, staffing patterns supportive of small-group facilitation, and assessment models capable of measuring competence rather than recall [7].

Digital innovations strengthen this alignment by scaling case-based cognition in contexts where patient flow and mentorship may be constrained. AyurCeL provides structured access to well-documented clinical case studies and post-publication critique, supporting continuous problem-oriented learning and reflective practice [36]. AyurSIM extends experiential learning through virtual patient case simulations built around problem solving tasks and reflective practice, designed to cultivate critical thinking and bridge theory-practice gaps in Ayurveda

[36]. Together, these platforms operationalize PBL-like cognition (problem formulation, reasoning, feedback, reflection) and may help address clinical exposure deficits.

DISCUSSION

This synthesis supports PBL as a cognitive reform framework in clinical education—restructuring learning from passive content consumption to active inquiry, integrative reasoning, and metacognitive self-regulation. Evidence indicates that PBL can improve higher-order cognition without necessarily producing uniform gains in short-term recall, aligning with the expectation that clinical competence depends on interpretation and decision-making rather than memorization alone [18, 29]. Comparative assessment evidence using MCQ cognitive taxonomies and OSCEs demonstrates statistically significant performance advantages among PBL cohorts [27], while Indian institutional audits and learner perception studies reinforce feasibility and perceived value [30, 27].

For Ayurveda education, the cognitive reform imperative is structurally reinforced by documented deficits in clinical exposure and graduate readiness [3, 4, 5]. NCISM's competency-based reforms directly incorporate PBL-compatible mechanisms—early clinical exposure, integrated learning, and workplace-based assessment—suggesting

an unprecedented opportunity to institutionalize cognitive reform at scale [7, 8]. However, implementation fidelity remains the principal risk: without faculty development, protected small-group facilitation time, and robust workplace-based assessment systems, PBL may be reduced to superficial “case discussion” without measurable cognitive outcomes.

Digital case repositories and simulation systems (AyurCeL, AyurSIM) represent scalable solutions to address variability in patient flow and mentorship, enabling repetitive exposure to structured clinical problems and reflective critique—two pillars of cognitive reform [36]. A rational roadmap therefore is not an “either-or” between PBL and lectures but a curriculum architecture that blends: (i) structured problem tutorials, (ii) bedside/field exposure, (iii) simulation/case platforms, and (iv) competency-based assessment.

Implications for implementation in Ayurveda colleges

Recommended implementation bundle (evidence-aligned):

- Hybrid PBL embedded within lecture-dominant schedules as an incremental reform [20].

- Early clinical exposure beginning in Year 1 with structured reflection tasks [7].
- Workplace-based assessment (direct observation, logs, feedback) aligned with competence outcomes [7].
- Case repositories and simulation (Ayur CeL / Ayur SIM) to standardize exposure and strengthen reflective learning [36].
- Faculty development targeted to facilitation skill, case design, and assessment literacy via workshops on contemporary Problem-Based Learning models, supported by standardized provision of essential PBL [7, 32, 17, 33].
- Ensure uniform and effective implementation across various institutions.

Limitations

This review is a narrative synthesis using heterogeneous study designs and outcomes; effect sizes and pooled estimates were not derived. Several included studies are perception-based or single-institution audits, limiting generalizability. Ayurveda-specific PBL evidence remains comparatively sparse; therefore, transfer of findings from conventional medical education should be

interpreted as evidence-informed plausibility rather than definitive equivalence.

CONCLUSION

PBL functions as a cognitive reform strategy that strengthens higher-order reasoning, metacognition, and applied competence; domains central to modern clinical education. Evidence from validated comparative assessments and Indian implementation studies supports PBL's capacity to improve performance on higher cognitive outcomes and to enhance engagement, communication, and reflective learning. In medical education, where gaps in clinical exposure and competence are well documented, contemporary competency-based reforms under NCISM, together with the emergence of digital case repositories and simulation platforms, provide a timely ecosystem for institutionalizing PBL-aligned cognitive reform. Future research in Medical education should prioritize implementation fidelity, faculty capacity building, and workplace-based outcome measures.

Acknowledgements

The authors thank Banaras Hindu University (BHU) for academic support and acknowledge the scholars whose work informed this review. Language refinement was assisted by a language model-based tool; all scientific content was independently

verified, and all authors approved the final manuscript.

Financial Support:

This project receives no financial support.

Conflict of Interest:

In this case, there is no conflict of interest.

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