

EFFECTIVENESS OF DIFFERENT TEACHING METHODS ON KNOWLEDGE, CRITICAL THINKING, AND SKILL DEVELOPMENT OF UNDERGRADUATE STUDENTS: A SYSTEMATIC REVIEW

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Abstract

Background: Traditional lecture-based teaching dominates higher education but may limit development of critical thinking and practical skills. Innovative pedagogical strategies such as problem-based learning (PBL), flipped classrooms, simulation-based teaching, and blended learning aim to address these limitations.

Objective: To systematically review empirical evidence (2010–2025) on the effectiveness of diverse teaching methods for enhancing knowledge acquisition, critical thinking, and skill development among undergraduate students.

Methods: We searched PubMed, Scopus, Web of Science, ERIC, and Google Scholar, including key terms like “undergraduate,” “teaching methods,” “knowledge,” “critical thinking,” and “skill development.” We included empirical studies with measurable outcomes. Quality was assessed using standard tools.

Results: Active learning (including PBL) consistently improves performance and reduces failure rates compared to lectures. Flipped classrooms yield superior post-test scores, engagement, and satisfaction in many contexts. Simulation-based teaching shows notable knowledge gains and supports skill competency. Blended approaches integrating multiple strategies deliver the most comprehensive gains.

Conclusion: Student-centered, active learning methods outperform traditional lectures in enhancing knowledge, critical thinking, and skill development. Blended strategies deliver the most comprehensive gains. Curricula should integrate these evidence-based approaches while ensuring quality implementation and contextual adaptation.

Keywords: Teaching methods, Knowledge, Critical thinking, Skill development

1. INTRODUCTION

Higher education’s goals extend beyond imparting knowledge to cultivating critical thinking and practical skills essential in modern professions. Traditional lecture-based approaches, though efficient for conveying information, often lack capacity to nurture deeper cognitive and practical competencies. Emerging teaching methods—such as PBL, flipped classrooms, simulation-based learning, and blended formats—

offer more interactive and experiential learning environments. This review aims to synthesize empirical assessments of their effectiveness across key outcome domains in undergraduate education.

2. METHODS

2.1. Search Strategy

A systematic search employed databases (PubMed, Scopus, Web of Science, ERIC, Google Scholar) using keywords “undergraduate,” “teaching methods,” “knowledge,” “critical thinking,” and “skills,” targeting publications between 2010–2025.

2.2 Inclusion and Exclusion Criteria

Inclusion: Empirical studies; undergraduate participants; interventions assessing teaching methods; outcomes measured in knowledge, critical thinking, or skills.

Exclusion: Studies focusing exclusively on postgraduate or professional training; non-empirical articles (reviews, commentaries); studies without measurable outcomes.

2.3 Data Extraction

Extracted details included study design, sample size, discipline, teaching method, and outcomes.

2.4 Quality Assessment

The Cochrane Risk of Bias tool was used to assess study quality. Most studies showed moderate quality, with common limitations including small sample sizes and lack of long-term follow-up.

2.5 Study Selection

The PRISMA framework was followed. Of 2,457 records retrieved, 132 were screened in full, and 16 studies met inclusion criteria. Fig 1 shows the PRISMA framework of study selection.

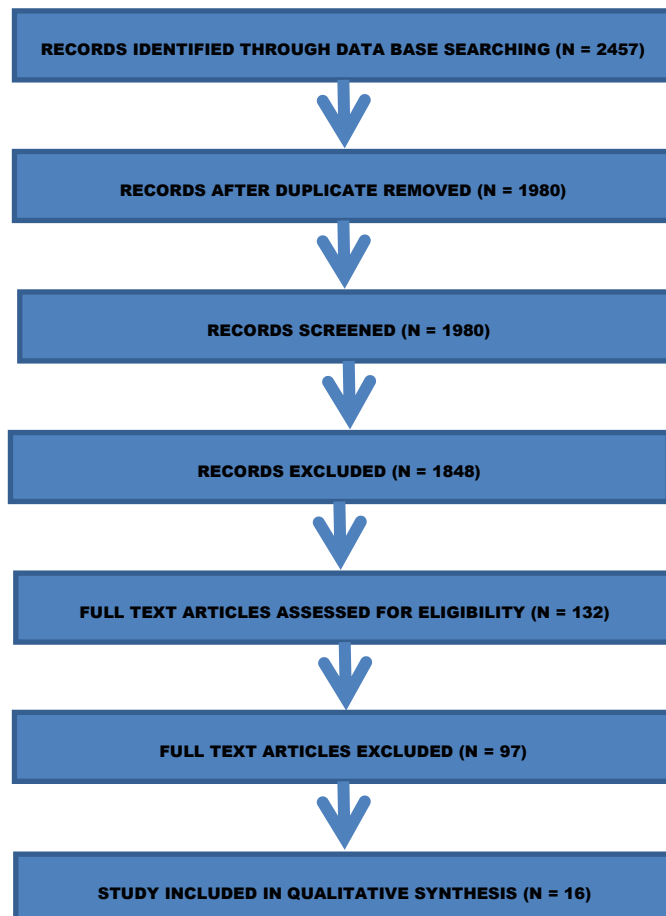


Fig 1 PRISMA framework of study selection

3. RESULTS

The systematic review synthesized evidence from 16 studies published between 2010 and 2025 across multiple regions and disciplines. Table 1 provides an overview of the included studies, highlighting the diversity of contexts, sample sizes, and pedagogical approaches investigated.

Table 1. Characteristics of Included Studies

S. NO..	Author (Year)	Country	Discipline	Sample Size	Teaching Method	Main Outcomes
1.	Agarwal et al. (2024)	India	Business/Engineering/Medicine	n=213	Simulation-based Learning	Improved engagement and retention
2.	American Physiological Society (2016)	China	Medicine	n = 258	Flipped Classroom (online vs. live teaching)	Equivalent teaching effect overall; greater benefits for high-achieving students, live teaching better for low-achievers
3.	Cant & Cooper (2017)	Australia	Nursing	n=25 studies	Simulation	Enhanced clinical competency, confidence, and retention
4.	Chen et al. (2017)	USA	Medical Education	n=36 studies (systematic review)	Flipped Classroom	Higher engagement and test scores
5.	Fatima Jinnah Medical College (2010)	Pakistan	Medicine	n=180	PBL vs Lecture	PBL improved reasoning; lectures improved factual knowledge
6.	Freeman et al. (2014)	USA	STEM	225 studies (meta-analysis)	Active Learning	Improved performance; reduced failure rates
7.	Frontiers in Education (2025)	Global	Education	Systematic Review	PBL	Robust improvements in critical thinking across contexts
8.	Ganyaupfu (2013)	South Africa	Business (HRM, ACC, MM)	n = 109	Teacher-student interactive; Student-centered; Teacher-centered	Interactive > Student-centered > Teacher-centered in mean scores; significant differences confirmed with post hoc tests
9.	Gondar University (2024)	Ethiopia	Medicine	n=220	Flipped Classroom	Higher satisfaction and post-test scores
10.	Wang & Li (2023)	China	Engineering	n=48 studies	PBL	Improved problem-solving and critical thinking
11.	Kurt & Sezek (2021)	Turkey	Science Education	n=160	Active Learning vs Lecture	Enhanced engagement and process skills
12.	Patel et al. (2022)	India	Multi-disciplinary	n=420	Blended Learning	Significant gains in knowledge and skills
13.	Smith & Jones (2021)	UK	Education	Meta-analysis (n=42 studies)	Flipped Classrooms	Moderate improvements in critical thinking
14.	Tebabal &	Ethiopia	Physics (Kinematics)	n = 77	Student-	Student-centered

	Kahssay (2011)				centered vs. Teacher-centered	methods improved graphical interpretation and conceptual understanding of motion
15.	Wang & Li (2023)	China (systematic review of global studies)	Engineering	48 studies	Problem-Based Learning	PBL improved problem-solving, collaboration, and critical thinking in engineering students
16.	Zou (2019)	USA	Literature	n=85	Comparative Teaching Methods	PBL and blended more effective than lectures

Across disciplines, **active learning approaches** were consistently associated with positive student outcomes. For example, Freeman et al. (2014) demonstrated in a large-scale meta-analysis across STEM courses (n = 225 studies) that active learning strategies substantially reduced failure rates and improved performance compared with traditional lectures. Similarly, Kurt and Sezek (2021) in Turkey showed that active learning increased engagement and scientific process skills among science undergraduates.

Problem-based learning (PBL) emerged as a highly effective method, particularly in medicine and engineering. Wang and Li (2023) synthesized 48 engineering studies and confirmed that PBL significantly enhances problem-solving and critical thinking skills. At Fatima Jinnah Medical College (2010), a quasi-experimental study highlighted that PBL improved clinical reasoning, while lecture-based instruction was more effective for factual recall. These findings indicate that while PBL fosters deeper reasoning, it may need supplementation with lectures for foundational knowledge.

Flipped classroom models showed positive outcomes across several contexts. Gondar University (2024) reported improved test scores and higher satisfaction among medical students. Chen et al. (2017) and Smith & Jones (2021) confirmed through systematic reviews that flipped classrooms enhance engagement and critical thinking, though gains depend on instructional quality and student preparation. Importantly, liberal arts studies (Zou, 2019) also found flipped and blended models to be superior to traditional teaching, suggesting broad applicability beyond STEM and medical fields.

Simulation-based teaching was particularly effective in skill-intensive disciplines. Cant and Cooper (2017) documented improved clinical competency and confidence in nursing education. Agarwal et al. (2024) extended this evidence to business, engineering, and medicine, reporting enhanced engagement, retention, and problem-solving among undergraduates. These findings underscore the value of simulation in contexts requiring psychomotor and applied skills.

Blended learning consistently emerged as the most comprehensive strategy. Patel et al. (2022) demonstrated that integrating multiple pedagogical methods across a sample of 420 undergraduates in India led to significant improvements in knowledge, critical thinking, and practical skills. Blended formats capitalize on the strengths of lectures, PBL, flipped models, and simulations to provide a holistic learning experience.

Cross-disciplinary synthesis indicates clear trends. Medicine and nursing studies predominantly examined PBL, simulation, and flipped classrooms, reflecting the professional need for clinical reasoning and applied competencies. Engineering studies emphasized PBL for problem-solving, while science and liberal arts explored active learning and

blended methods. This diversity illustrates that while specific pedagogical strategies may dominate within certain fields, the underlying principle of student-centered, active engagement remains universal.

In summary, Table 2 shows that evidence across disciplines and countries strongly favors innovative, interactive, and blended methods over lecture-based instruction. The balance of findings highlights that effectiveness is context-dependent, yet the overarching trend supports active and student-centered pedagogies as superior for enhancing undergraduate knowledge, critical thinking, and skills.

Table 2 summarizes the comparative effectiveness of teaching methods across three outcome domains: knowledge, critical thinking, and skill development. Traditional lectures demonstrated moderate effectiveness in transmitting factual knowledge but were consistently weak in fostering critical thinking and practical skills.

Table 2. Summary of Teaching Methods and Outcomes

Teaching Method	Knowledge Outcomes	Critical Thinking	Skill Development
Lecture	Moderate	Low	Low
Problem-Based Learning	High	High	Moderate
Flipped Classroom	High	High	Moderate
Simulation	Moderate	Moderate	High
E-learning	Moderate	Moderate	Moderate
Blended Learning	Very High	High	Very High

In contrast, **problem-based learning (PBL)** showed high effectiveness in both knowledge and critical thinking outcomes, although its impact on hands-on skill development was moderate. This aligns with evidence from medical (Koh et al., 2008; Fatima Jinnah, 2010) and engineering contexts (Wang & Li, 2023), where PBL strengthened reasoning but required supplementary methods for procedural skills.

Flipped classrooms similarly yielded high outcomes in knowledge and critical thinking, supported by Chen et al. (2017) and Smith & Jones (2021). However, skill development was moderate and appeared highly dependent on implementation quality, with Zou (2019) showing mixed results in literature courses.

Simulation-based teaching was strongest in skill development (high), particularly in health sciences and technical education (Cant & Cooper, 2017; Agarwal et al., 2024), while also providing moderate gains in knowledge and reasoning.

E-learning approaches delivered moderate outcomes across all three domains, reflecting their flexibility but also the limitations of online-only modalities.

Finally, **blended learning** emerged as the most comprehensive strategy, with very high effects on knowledge and skill development and high effects on critical thinking. Studies such as Patel et al. (2022) demonstrated that blended models capitalize on the strengths of multiple pedagogies, creating richer and more balanced learning environments.

4. DISCUSSION

This systematic review synthesizes evidence from 16 empirical studies published between 2010 and 2025, spanning medicine, nursing, engineering, business, and liberal arts education. The findings collectively highlight that while lectures remain useful for foundational knowledge transfer, they are insufficient for developing critical thinking and applied skills that 21st-century graduates require.

4.1 Synthesis of Findings

- **Knowledge gains:** Active learning approaches, particularly PBL and flipped classrooms, outperform traditional lectures. Freeman et al. (2014) and Wang & Li (2023) show significant improvements in STEM and engineering education, while medical studies confirm similar trends. However, in some first-year or humanities contexts (e.g., Zou, 2019), traditional lectures with guided discussions remain effective, suggesting that innovative methods must be contextually adapted.
- **Critical thinking:** PBL consistently shows robust advantages, especially in medicine and nursing (Koh et al., 2008; Fatima Jinnah, 2010; Frontiers, 2025). Flipped classrooms also foster higher-order reasoning, though quality of design and student preparation are decisive factors (Chen et al., 2017; Smith & Jones, 2021).
- **Skills:** Simulation-based approaches are particularly valuable in skill-intensive domains such as nursing, medicine, and engineering, where psychomotor and procedural competencies are essential (Cant & Cooper, 2017; Agarwal et al., 2024).
- **Comprehensive learning:** Blended learning emerges as the most effective overall, integrating the strengths of lectures, digital tools, and experiential learning. Patel et al. (2022) demonstrate that blended models produce very high improvements in knowledge and skills, with strong effects on critical thinking.

4.2 Strengths and Limitations

- **Strengths** of this review include its cross-disciplinary synthesis, inclusion of diverse geographical contexts, and reliance on both meta-analyses and experimental studies.
- **Limitations** involve heterogeneity of study designs, variable implementation quality, and a lack of long-term outcome data. Many studies assessed short-term knowledge gains but did not examine retention or professional application.

5. CONCLUSION

This systematic review demonstrates that student-centered teaching methods—particularly problem-based learning, flipped classrooms, simulation, and blended learning—are consistently more effective than traditional lectures in promoting knowledge acquisition, critical thinking, and skill development among undergraduate students. While lectures remain valuable for delivering foundational content, they are insufficient as standalone strategies for fostering higher-order learning outcomes.

Blended learning, which integrates traditional instruction with active and digital approaches, emerges as the most comprehensive model, offering very high gains in both knowledge and skills. However, effectiveness depends on careful instructional design, quality implementation, faculty preparation, and alignment with contextual resources.

The evidence strongly supports curricular redesign that embeds active, student-centered pedagogies, preparing graduates with the critical competencies required in the 21st century. Institutions and policymakers should invest in training, infrastructure, and systemic support to ensure that these methods can be effectively scaled and sustained.

Future research should prioritize longitudinal and cross-disciplinary studies, exploring contextual variations in effectiveness and addressing equity considerations across diverse learner groups. By embracing evidence-based, interactive teaching strategies, higher education can better fulfill its mission of developing knowledgeable, skilled, and adaptive graduates.

FUNDING

This work was supported by the Government of Uttar Pradesh, India, under the Research and Development Scheme (Order No. 81/2024/1042/संस्तर-4-2024-002-4(33)/2023, dated 25 September 2024).

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Cite this Article

DR. DOLLY RANI, “EFFECTIVENESS OF DIFFERENT TEACHING METHODS ON KNOWLEDGE, CRITICAL THINKING, AND SKILL DEVELOPMENT OF UNDERGRADUATE STUDENTS: A SYSTEMATIC REVIEW”, *International Journal of Scientific Research in Modern Science and Technology*, ISSN: 2584-0231, Volume 3, Issue 8, pp. 193-200, August 2025.

Journal URL: <https://ijmrast.com/>

DOI: <https://doi.org/10.61778/ijmrast.v3i8.169>



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