Review Article

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Medical Education Practices and Their Effects on Educational Outcomes in India: A Scoping Review and Evidence Gap Map

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Introduction: The landscape of medical education research has undergone a considerable change in India. This scoping review and the evidence gap map (EGM) explore the medical education techniques in curricular components of medical education and identify the gaps in medical education research in India.

Methods: Studies published from inception till 13th June 2025 in five databases of MEDLINE (PubMed), Scopus, Embase, Web of Science, and Cochrane were included. Studies reporting on medical education methods in the curricular components (content, teaching, learning, educational environment, educational strategies, assessment, and evaluation) of medical education, and their effects on reactions/attitudes, knowledge, skills, behaviours, practices, and patient outcomes in the Indian context, were included. Screening and data extraction were conducted by two independent reviewers, with conflicts adjudicated by a third reviewer. EGM was developed using Eppi-Reviewer and Eppi-Mapper. Database search yielded 4342 unique studies, among which 607 studies were finally included in the review.

Results: The majority of studies were conducted on MBBS students (n=534, 88%), while 59 (9.7%) were conducted among MD-MS-DNB students. Teaching-Learning methods were the common curricular components studied (n=548, 90.3%). Physiology (n=118, 19.4%) followed by pharmacology (n=74, 12.2%) were the most common subjects on which studies were conducted. Most studies assessed Kirkpatrick's Level II (n=570, 93.9%), followed by Level 1 (n=545, 89.8%). The majority of the studies were unfunded (n=589, 97%). Positive educational outcomes were reported for the intervention under evaluation in 83.0% (n=504) of the included studies.

Conclusion: In India, gaps exist in medical education research regarding study populations (postgraduates), curriculum components (educational environment, assessment), and levels of outcomes (levels 3 and 4).

Keywords: Competency based education, Medical education, Curriculum

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Introduction

Medical institutions are adapting their curricula to produce physicians equipped to address both current and emerging challenges in population health and clinical practice (1). Medical education involves interactions among learners, teachers, the educational environment, and various approaches that enable learners to achieve its objectives. India, the most populous country in the world, trains more than 150,000 medical undergraduate and post-graduate students per year in 704 medical colleges across the country (2). The majority of these students belong to Generation Z (Gen Z), who require creative ways to inculcate the medical curriculum (3).

Until 2019, India followed a traditional medical education curriculum as prescribed by the erstwhile Medical Council of India (MCI) The country shifted its curriculum towards the Competency-Based Medical Education (CBME) from 2019 (4) considering detailed competencies and sub-competencies in each subject as well as the domain (knowledge, attitude & psychomotor) addressed by each competency. This program is adaptable, adjusting to the learner's pace, and encourages students to be proactive in their own educational growth and progression (5). Differing from traditional education programs, the concept of CBME is focused on learners' skills and abilities to undertake predefined competencies in the specified domain (6, 7), with a more student-centred approach (8) and garnering a positive reception from the students (9).

While the broader curriculum and competencies are mandated by India's apex medical education body (10), individual medical colleges and departments are responsible for planning and implementing the instructional strategies and assessment frameworks necessary to achieve these educational objectives. Context-specific innovation in medical education techniques indicates that diverse models may develop over time. Given India's extensive history in medical education and its recent curricular transition, it is imperative to examine the current research landscape regarding effective pedagogical practices in the country. A preliminary search of PubMed and Scopus was conducted by the authors, and no scoping review on the topic was found. Therefore, we aimed to explore effective medical education techniques across various curricular components of medical education in India and, through an evidence gap map (EGM), present the gaps.

Methods

This research was conducted using the "PRISMA-ScR (Preferred Reporting Items for Systematic Review and Meta- Analysis-Extension for Scoping Reviews)" reporting guidelines (10) and the framework recommended by the Joanna Briggs Institute (JBI) (11). A Population-Concept-Context (PCC) framework was used to expand the review question. The scoping review was done as per the protocol submitted with the Open Science Framework (https://osf.io/).

Eligibility criteria

The population includes medical students (undergraduate [MBBS], postgraduate [MD/MS/DNB], sub-speciality [DM/MCh/DrNB]), and medical faculty. The concept assessed was medical education techniques across the curricular components (content, teaching, learning, educational environment, educational strategies, assessment and evaluation) and their effects on reactions/attitudes, knowledge, skills, behaviours, practices, and patient outcomes. The context was studies from India. All original studies, including randomized controlled trials, non-randomized controlled trials (RCTs), before-and-after studies (quasi-experimental), interrupted time-series studies, analytical observational studies, and mixed-methods studies, were considered. Text, opinion papers, and reviews were excluded.

Search Strategy

A brainstorming session was undertaken by the authors (APG, PD and AD) to identify potential keywords and sources for the search strategy. Five databases, including MEDLINE (PubMed), Scopus, Embase, Web of Science, and Cochrane, were searched from inception till 13th June 2025 (Supplementary Table S1). Only studies published in English were included.

Screening of the studies

Following the search, all identified citations were uploaded into NESTED Knowledge for de-duplication and screening (12). Following a pilot test (50 studies for all reviewers), studies were divided, and each study was screened (title-abstract) by two independent reviewers. Two reviewers reviewed each potentially eligible full-text article independently to identify the final list of studies for data extraction. Discrepancies regarding the inclusion of the study during the screening process were resolved by a consensus meeting at the end of the independent assessment to finalize the eligibility of the article.

Disagreements regarding the study eligibility was adjudicated by third author.

Data extraction

A data extraction sheet was made in MS Excel and piloted. The pilot data extraction sheet was refined during the data extraction process, with modifications made as needed based on the included evidence sources. Data were extracted from each included study by two independent reviewers using MS Excel. Extracted data included variables essential for study classification: interventions, designs, timeframes, institutional settings, assessed outcomes, and methodological quality. Disagreements between reviewers were resolved through discussion, with unresolved discrepancies adjudicated by a third reviewer.

Quality assessment

The methodological quality of the included quantitative studies was assessed using the "Medical Education Research Study Quality Instrument (MERSQI)" (13) by two independent reviewers. For mixed-methods studies, only the quantitative component on educational interventions and their effectiveness was assessed using MERSQI, in accordance with the instrument's intended scope. MERSQI has 10 items assessing various domains of medical education research, with a maximum score of 18. The MERSQI score was considered as a continuous measure of methodological quality. To facilitate interpretation, we considered studies with MERSQI scores >12.5 to have relatively high methodological quality, based on thresholds previously adopted in the medical education literature (14, 15). However, no validated cut-offs exist for moderate- or low-quality studies; therefore, these categories were not considered. Hence, all studies with MERSQI scores ≤12.5 were labelled as a single category-moderate to low- for the depiction in the evidence and gap map.

Data Synthesis and Presentation

The data were presented in tabular form with key variables that answered the research question of the index scoping review. A narrative summary of the results has also been provided. When the study institution or state was not explicitly reported in the article, the first author's affiliation was used as a proxy for the study location. Robustness was assessed through a sensitivity analysis in which we analyzed the geographic locations (states) of studies that clearly specified the study area/location in the manuscript and compared it with the main analysis.

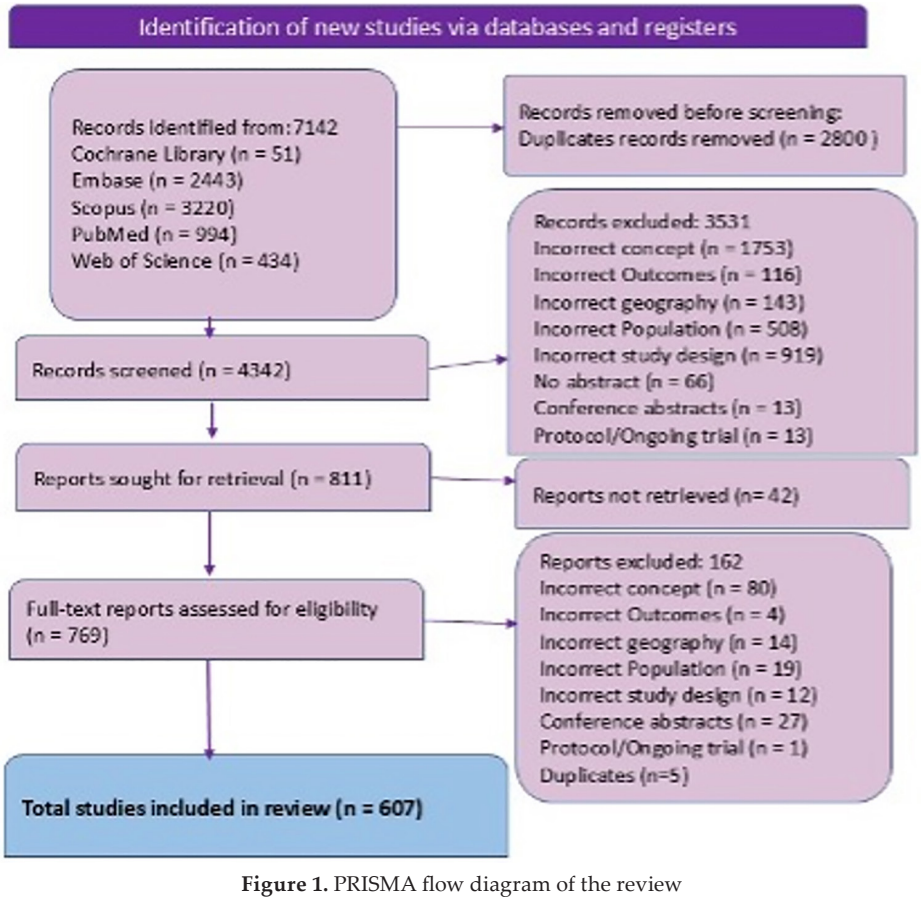

Figure 1. PRISMA flow diagram of the review

For studies that did not report the year of study, the year of publication was used as a proxy for the study period. Outcomes were reported according to Kirkpatrick's levels of learning (16). Sensitivity analysis of the outcomes was conducted by including the studies with good quality as per MERSQI. An EGM based on the data extracted in the review was generated through Eppi-Reviewer, (17) and Eppi Mapper tools (18). The EGM was constructed by arranging the subjects/departments in rows and the educational outcomes (as per Kirkpatrick's levels) in columns. Circles within the cells of the EGM displayed studies by quality, as assessed by MERSQI (Green- Good quality and Orange- Moderate quality). Other variables, such as study population (MBBS, MD, Faculty), type of institute, year of study, place of study, and funding status, were used as filters in the map.

Results

Database search yielded 7142 studies. Following deduplication, 4342 underwent title-abstract screening. Among them, 811 articles were eligible for full-text review. The agreement rate for the title/abstract stage between the two reviewers was 91.3%, with a Cohen's Kappa of 0.81. Finally, 607 studies were eligible for the scoping review (Figure 1). The agreement rate for the full text review between the two reviewers was 83%, with a Cohen's Kappa of 0.69. The line list of the included studies, along with key study characteristics (N=607).

The included studies were conducted from 1981 to 2024. The summary characteristics of the included studies are presented in Table 1. Most of the studies were conducted among undergraduate (MBBS) students (n=534, 88%), while 60 studies (9.9%) were conducted at the postgraduate level (MD-MS-DNB) and 5 studies (0.8%) were conducted among super-speciality (DM-MCh-DNB) students. Medical faculties were study participants in 34 studies (5.6%).

Table 1. Summary characteristics of the included studies (N=607)

	Frequency (n)	% of 607 studies
Study population		
Undergraduate (MBBS, including interns)	534	88.0
Post-graduates (MD-MS-DNB)	60	9.9
Super specialty (DM-MCh-DNB)	5	0.8
Faculty	34	5.6
Senior Residents/Tutors	2	0.3
Common Teaching-Learning Methods		
Case-based Learning (CBL)	32	5.3
E-learning	28	4.6
Simulation-based education (SBE)/Training	29	4.8
Workshop based teaching-learning	23	3.8
Peer-assisted learning (PAL) (or Teaching)	17	2.8
Interactive teaching and learning (ITL) methods	17	2.8
Self-directed Learning (SDL)	17	2.8
Flipped classroom (FC)	13	2.1
Integrated Teaching Learning	13	2.1
Virtual methods of teaching learning	13	2.1
Problem based learning (PBL)	13	2.1
Competency-based Medical Education (CBME)	11	1.8
Power Point presentations	11	1.8
Early Clinical Exposure (ECE)	11	1.8
Teambased learning (TBL)	10	1.6
Common Interventions for Assessment-Evaluation		
Objective structured practical examination (OSPE)	15	2.5
Structured Oral Viva Voce (SOVV)	7	1.2
Objective Structured Clinical Examination (OSCE)	7	1.2
Formative assessment tool	6	1.0
Multiple choice questions	4	0.7
Mini-Clinical Evaluation Exercise (Mini-CEX)	3	0.5
Assessment blueprint designing	3	0.5
Computer Assisted Objective Structured Clinical Examination (CA-OSCE)	2	0.3

MBBS: Bachelor of Medicine, Bachelor of Surgery; MD: Doctor of Medicine; MS: Doctor of Surgery; DNB: Diplomate of National Board; DM: Doctorate of Medicine; MCh: Magister Chirurgiae

Curricular components studied

The most common medical educational model evaluated was CBME (n=386, 63.6%), while 221 (36.4%) were of the traditional model. Teaching-Learning methods were the most commonly studied curricular component evaluated for educational outcomes (n=548, 90.3%), followed by Assessment-Evaluation methods (n=59, 9.7%). The educational environment was assessed in three (0.5%) of the included studies.

Common Interventions (for Teaching-Learning & Assessment-Evaluation) and their outcomes

The most common teaching-learning methods evaluated in India were case-based Learning (n=32, 5.3%), followed by E-learning (n=28, 4.6%), simulation-based education (SBE)/ Training (n=29, 4.8%), workshop-based teaching-learning (n=23, 3.8%), peer-assisted learning (PAL) or teaching (n=17, 2.8%), interactive teaching and learning (ITL) methods (n=17, 2.8%), and self-directed Learning (SDL) (n=17, 2.8%). Objective Structured Practical Examination (n=15, 2.5%), followed by Structured Oral Viva Voce (SOVV) (n=7, 1.2%), Objective Structured Clinical Examination (n=7, 1.2%), and Formative assessment tools/techniques (n=6, 1.0%) were the most common Assessment-Evaluation methods studied in India (Table 1).

Study designs

Most of the studies were parallel-arm studies (n=428, 70.5%), while 179 (29.5%) were pre-post studies. Among them, 47 (7.7%) were RCTs and 18 (3.0%) were mixed-methods studies.

Among the included studies (N=607), the majority reported statistically significant improvements in the educational outcomes assessed in the intervention group ($p<0.05$) (n=468, 77.1%). Within the parallel-arm studies (n=428), which included controlled trials, 406 reported results based on hypothesis testing, and 22 reported exclusive descriptive data. Within the pre-post studies (n=179), 165 reported results based on hypothesis testing, and 14 reported only descriptive data. In total, 571 studies reported results based on hypothesis testing. Among these 571 studies, 442 (73.9%) reported that interventions showed significantly better educational outcomes than the comparator group.

Year and state of the studies

Most of the studies were conducted after the CBME was introduced (n=386, 63.6%). Karnataka (91, 15.0%) and Maharashtra (n=91, 15.0%) reported the majority of the studies, followed by Tamil Nadu (n=63, 10.4%), Gujarat (n=55, 9.1%), Kerala (n=40, 6.6%), Delhi (n=36, 5.9%), and Puducherry (n=32, 5.3%). A sensitivity analysis of studies reporting the actual research location showed that the estimates were robust.

Common institutes/Colleges

Kasturba Medical College, Manipal (n=17, 2.8%), followed by AIIMS New Delhi (n=13, 2.1%), Armed Forced Medical College Pune (n=12, 2.0%), JIPMER, Puducherry (n=12, 2.0%), Pramukhswami Medical College, Karamsad (n=12, 2.0%), Christian Medical College, Vellore (n=11, 1.8%), and Melaka Manipal Medical College (Manipal Campus) (n=11, 1.8%) were the most common institutions where the studies were conducted.

Type of institutes

The majority of the included studies were conducted in private medical colleges/universities (n=390, 64.3%), while 143 (23.6%) studies were conducted in state government colleges, 38 were undertaken in Institutes of National Importance (INIs) (6.3%), and 30 (4.9%) were done in central government institutions.

Subjects/Departments

Most of the studies were in pre-clinical departments, where physiology was the most common department (n=118, 19.4%), followed by Anatomy (n=67, 11.0%) and Biochemistry (n=64, 10.5%). Among the para-clinical departments, pharmacology was the most common department (n=74, 12.2%). Community medicine (n=42, 6.9%) was followed by Paediatrics (n=20, 3.3%), General Surgery (n=20, 3.3%), and Internal Medicine (n=18, 3.0%) (Supplementary Table S2).

Outcomes assessed and Kirkpatrick's levels

The most common outcomes assessed were knowledge (562, 92.6%) and reaction (545, 89.8%) in the included studies. 113 studies reported on skills (18.6%). Kirkpatrick's Level II (Learning- Acquisition of knowledge, attitude & skills) outcomes were the mostly reported ones (570, 93.9%), followed by Level I (Reaction- Feedback, Participant satisfaction) (545, 89.8%) (Supplementary Table S3). Since each study could examine multiple outcomes, the total percentage exceeded 100%. Level I and Level II outcomes were reported by 513 (84.5%) studies (Figure 2).

Funding status

The majority of the studies were non-funded (589, 97.0%), while 13 studies had extramural funding (2.2%) and 5 (0.8) had intramural funding.

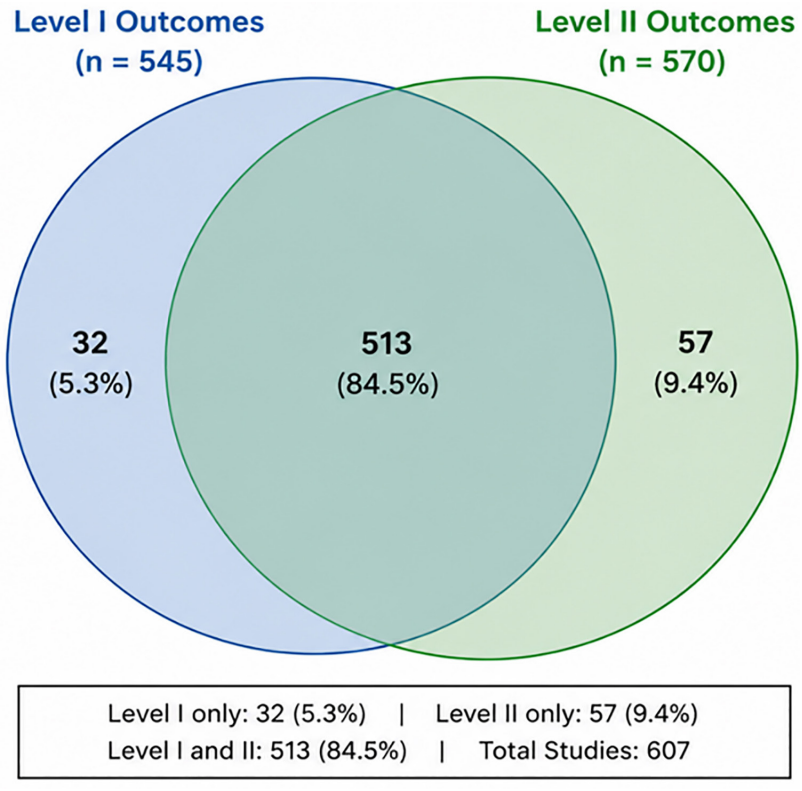

Figure 2. Venn diagram showing the level I and II outcomes reported in the included studies

Quality of the studies

According to the MERSQI, 238 (39.2%) studies had a score >12.5 and were labelled as high-quality studies. 369 (60.8%) studies were found to have moderate to low quality (MERSQI scores between 6 and 12.5).

Sensitivity analysis

A sensitivity analysis that included only high-quality studies (N=336) revealed that the distribution of study population, teaching-learning methods, assessment, curricular components, department/subjects, type of institutes, outcomes assessed, and Kirkpatrick's levels of learning was similar to that in the main analysis with 607 studies.

Evidence and gap map

The existing scenario of studies assessing the educational outcomes at Kirkpatrick's levels, by subject and by study quality, is presented in the attached EGM. It reveals a gap in studies on postgraduate medical education and higher levels of outcomes.

Discussion

The most frequently evaluated curricular component was teaching–learning methods (90.3%), which far outweighed assessment (9.7%) and the educational environment (0.5%). Learning environment is a key component of the curriculum, which can have a significant impact on the student's educational outcomes (19). The target audience in most studies comprised MBBS students (88%), with relatively fewer studies involving postgraduates (10.7%). Thus, there is a clear disproportion between the enrolment ratio of undergraduate to postgraduate students (≈1.59; 107,948: 67,802) and the volume of research conducted in these groups (≈9.07; 88%: 9.7%), indicating a substantial overrepresentation of undergraduate populations in the literature (2).

The current review mapped studies to the 'justification' category, per the Cook et al. framework for medical research. Justification studies focus on comparing educational interventions to answer the question "Does the new intervention work?" (20). The majority employed parallel-arm designs (70.5%), while pre-post designs accounted for 29.5%. Most of the teaching methods demonstrated favorable educational outcomes in the included studies. Past reviews, but with limited scope, have shown that the current medical education research in India is predominantly quantitative (21, 22) relying solely on survey findings, which limits our ability to capture the nuances of medical education. Longitudinal studies, combined with qualitative and mixed-methods approaches,

can provide rich insights into how learners, educators, and institutions negotiate, adapt through curricular innovations, and achieve higher-order outcomes over the period. Dolmans and Tigelaar, et al. (2012) (23) have proposed a design-based educational model that explores participative interactions among various stakeholders in the educational ecosystem in real-world settings. Adopting these approaches would help educators and researchers to generate contextually relevant and acceptable evidence that not only informs curriculum development but also supports contextually relevant educational reforms. Given its inherent capacity to test and refine learning theories, design-based research can be implemented in local educational settings to assess the validity of learning theories in India. Based on the findings, the theories could be modified or retained to inform the framing of interventions and outcome assessments.

In the present scoping review, the most frequently evaluated outcome was as per Kirkpatrick's Level II (Learning—acquisition of knowledge, attitude and skills), followed by Kirkpatrick's Level I. Boet et al. have highlighted that most educational research focuses on immediate participant outcomes, advocating for qualitative and mixed-methods studies to understand the complexities of teaching and learning processes (24). Future program evaluations should move beyond Kirkpatrick's Levels I and II to examine higher educational outcomes. Such advancements in evaluation practices would require better follow-up study designs to capture evidence that evolves in these settings. Most studies tend to focus on the undergraduate phase (88%). More studies are required to strengthen the continuum between undergraduate and postgraduate education by improving internship and residency programs and, subsequently, developing an effectively managed Continuing Professional Development (CPD) plan for certified professionals (25).

Geographically, most studies were conducted in Karnataka (15.0%) and Maharashtra (15.0%), followed by Tamil Nadu (10.4%). Nearly two-thirds of the included studies were conducted in private medical colleges, indicating an imbalance in the available evidence from India. This may reflect differences in institutional priorities, research support, accreditation-related incentives, and faculty workload between private and government institutions. Consequently, the current evidence base may underrepresent the experiences and educational practices of governmental medical colleges, potentially limiting the generalizability of the review findings across the diverse spectrum of medical institutions in India. Future studies should include a more balanced representation of both public and private institutions.

Regarding funding, most studies were unfunded (97%), which may explain why most assessed only lower levels of Kirkpatrick's outcomes. Medical education research in general is underfunded (26). The chronic underfunding and under-recognition of medical education research affect researchers' motivation and the quality of the research (27, 28). The quality of medical education research has been reported to be significantly better when funded and carried out by professionals experienced in medical education research (28). Grants for medical education by organizations for specific groups of medical and health education research are available across the globe (27) which can be emulated in Indian settings as well.

Although challenges exist in undertaking medical education research in institutions (29) the benefits outweigh the risks/challenges. The nature of evidence in medical education is complex, dynamic, and context dependent. Unlike the predictable models of experimental sciences, educational settings are socially constructed, value-laden, and continuously evolving. Consequently, researchers must draw on multiple forms of evidence—quantitative, qualitative, and mixed-methods—to capture the richness and depth of educational phenomena. Harden, et al. (1999) recommended using the QUEST framework that assesses Quality, Utility, Extent, Strength, Target, and Setting (QUEST) of the evidence. Given the complex nature of education, behaviours tend to be emergent, unpredictable, and adaptive; hence, explanations of educational phenomena require more than simplistic cause–and–effect generalisations (30). Taken together, these perspectives underscore that evidence in education is best viewed as iterative and evolving, oriented towards patterns and relationships that inform thoughtful professional judgment in context rather than rigid, top-down prescriptions. The findings of the present scoping review may be reviewed in light of the aforementioned nature of evidence in educational sciences.

Future medical education research in India should address the gaps identified in this scoping review. This includes specific curricular components, participant groups, departments, educational outcomes, and funding. In terms of participants, while most research focuses on undergraduate students, postgraduate students (MD-MS-DNB and DM-MCh-DNB) and faculty members require greater inclusion. Most studies currently report lower-level Kirkpatrick outcomes,

Table 2. Recommended research questions in medical education in India based on the gaps identified

1. To what extent do novel teaching, learning, and assessment strategies in undergraduate and postgraduate medical education lead to sustained changes in clinicians' workplace behaviour (Kirkpatrick Level 3) and measurable improvements in patient care processes and health outcomes (Kirkpatrick Level 4)?
Research priorities:
i. *Clinical and super-speciality disciplines*
ii. *Postgraduate training programmes*
iii. *Low-cost, scalable educational interventions*
iv. *Longitudinal designs linking training exposure to service delivery and patient outcomes*
2. Do faculty development programmes lead to demonstrable changes in faculty teaching, supervision, and assessment practices (Kirkpatrick Level 3), and do these changes result in improved learner competence, clinical performance, and patient-related outcomes (Kirkpatrick Level 4)?
Research priorities:
v. *Multi-centre and multi-state longitudinal evaluations*
vi. *Comparative effectiveness of different faculty development models*
vii. *Linkage between faculty behaviour change and learner/patient outcomes*
3. How do interventions aimed at improving the educational environment influence learner and faculty behaviour in clinical settings (Kirkpatrick Level 3), and what is their impact on quality of care, patient safety, and service delivery outcomes (Kirkpatrick Level 4)?
Research priorities:
viii. *Behavioural outcomes such as professionalism, teamwork, and adherence to clinical protocols*
ix. *Sustainability of environmental interventions over time*
x. *Patient safety indicators and quality-of-care metrics*
4. What are the real-world experiences of students and faculty with the implementation of CBME at undergraduate and postgraduate levels?
Research priorities:
xi. *Differential effects across institution types (government vs private)*
xii. *Discipline-specific behavioural and outcome indicators*
xiii. *Unintended consequences of CBME on service delivery*
5. Which organisational, leadership, and contextual factors facilitate or impede translation of CBME reforms into observable behaviour change among learners and faculty (Kirkpatrick Level 3) and improved patient and health system outcomes (Kirkpatrick Level 4)?
Research priorities:
xiv. *Leadership and governance mechanisms*
xv. *Faculty workload and staffing patterns*
xvi. *Regulatory and accreditation pressures*
xvii. *Context-specific implementation strategies for diverse settings*
6. Development of context specific framework or theories that explains the behaviours and phenomenon of interest in education (e.g., identify formation as a student/teacher, trust building, entrustment, feedback negotiation, development of reasoning ability etc) that support the contextual decision making.

indicating a clear need to prioritize higher-level educational outcomes such as behavior change and its system and patient-level impact. It is also essential to consider level III and level IV outcomes specific to various departments and topics, to enable their measurement. Given that 97% of studies were non-funded, a systematic grant or funding system for enhancing the quality of medical education research can be established in India. A tentative list of research questions for Indian medical education research is presented in Table 2.

There were several limitations in the current scoping review. Proxy locations were used for studies that did not explicitly provide this information. The non-inclusion of grey literature might have excluded relevant studies. The relatively low number of studies before 1997 suggests the potential for missing databases or sources in the search, where such older studies might have been available, which is another limitation. Given that 83% of studies reported positive educational outcomes, publication bias is likely, because studies with negative or no-difference results are less likely to be published. Owing to the substantial heterogeneity in study designs, interventions, outcome measures, and statistical reporting, formal statistical assessment of publication bias was not feasible. Consequently, the overall findings should be interpreted with caution.

Conclusion

Education, as a social science, is inherently constructive; therefore, the evidence it generates is context specific. The current scoping review highlights the gaps in medical education research regarding study populations, curriculum components, settings, and outcome levels in India.

It is recommended that context-specific research studies be undertaken to address the above gaps and improve the overall educational environment and outcomes in Indian medical education. A systematic funding mechanism also needs to be established in India to support quality and impactful medical education research. Further, systematic reviews are needed to evaluate the evidence regarding specific curricular components and the mechanisms underlying their educational outcomes.

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Authors' contribution

AP.G conceptualized the study, developed the methodology, contributed to the search strategy, supervised the review process, contributed to screening, data extraction and quality assessment, conducted the data synthesis and interpretation, developed the evidence gap map, and drafted and critically revised the manuscript. A.D and P.D contributed to the methodology, search strategy, supervision of the review process, interpretation of findings, and critical revision of the manuscript. KP.D contributed to the screening, data extraction quality assessment and review coordination of the manuscript; PD additionally contributed to the development of the search strategy. S.A, Y.B, P.Y, V.M, M.K, N.R, A.LNR and N.K contributed to study screening, data extraction and quality assessment. V.D and S.P contributed to the conceptualization of study, interpretation of findings and critically reviewed the manuscript for important intellectual content. All authors reviewed and approved the final version of the manuscript and agree to be accountable for their respective contributions to the work.

Conflict of interest

The authors state no conflict of interest.

Declaration of AI Use

No Large language models or artificial intelligence tools were used in the manuscript preparation. All scientific judgment, methodological decisions, and interpretation were performed by the authors.

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Supplementary Table S1: The adjusted search terms as per searched electronic databases [Date of search: 13th June 2025]

Database	No	Search Query	Results
PubMed			
	#1	"students, medical"[MeSH Terms] OR "student*"[Title/Abstract] OR "undergraduate*"[Title/Abstract] OR "post graduate*"[Title/Abstract] OR "postgraduate*"[Title/Abstract] OR "doctoral"[Title/Abstract] OR "specialit*"[Title/Abstract] OR "specialt*"[Title/Abstract] OR "super specialt*"[Title/Abstract] OR "superspecialt*"[Title/Abstract] OR "super specialit*"[Title/Abstract] OR "facult*"[Title/Abstract] OR "faculty, medical"[MeSH Terms] OR "medical teacher*"[Title/Abstract] OR "interns"[Title/Abstract] OR "CRRI"[Title/Abstract] OR "CMRI"[Title/Abstract] OR "internship"[Title/Abstract] OR "MBBS"[Title/Abstract]	6,28,108
	#2	"curricul*"[Title/Abstract] OR "teaching"[Title/Abstract] OR "learning"[Title/Abstract] OR "assessment"[Title/Abstract] OR "evaluation"[Title/Abstract] OR "curriculum"[MeSH Terms] OR "educational strateg*"[Title/Abstract] OR "educational environment"[Title/Abstract] OR "learning environment"[Title/Abstract] OR "student-centred"[Title/Abstract] OR "Continuing Medical Education"[Title/Abstract] OR "education, medical, continuing"[MeSH Terms] OR "faculty development"[Title/Abstract] OR "faculty training*"[Title/Abstract] OR "CISP"[Title/Abstract] OR "DOAP"[Title/Abstract] OR "self-directed learning"[Title/Abstract] OR "small group discussion"[Title/Abstract] OR "integrat*"[Title/Abstract] OR "Problem-based learning"[Title/Abstract] OR "Independent learning"[Title/Abstract] OR "task-based learning"[Title/Abstract] OR "Outcome-based education"[Title/Abstract] OR "Outcome-based learning"[Title/Abstract] OR "self-learning"[Title/Abstract] OR "multiprofessional education"[Title/Abstract] OR "OSCE"[Title/Abstract] OR "OSPE"[Title/Abstract] OR "innovat*"[Title/Abstract] OR "novel*"[Title/Abstract]	64,20,729
	#3	"education, medical"[MeSH Terms] OR "medical education"[Title/Abstract]	2,31,375
	#4	("curricul*"[Title/Abstract] OR "teaching"[Title/Abstract] OR "learning"[Title/Abstract] OR "assessment"[Title/Abstract] OR "evaluation"[Title/Abstract] OR "curriculum"[MeSH Terms] OR "educational strateg*"[Title/Abstract] OR "educational environment"[Title/Abstract] OR "learning environment"[Title/Abstract] OR "student-centred"[Title/Abstract] OR "Continuing Medical Education"[Title/Abstract] OR "education, medical, continuing"[MeSH Terms] OR "faculty development"[Title/Abstract] OR "faculty training*"[Title/Abstract] OR "CISP"[Title/Abstract] OR "DOAP"[Title/Abstract] OR "self-directed learning"[Title/Abstract] OR "small group discussion"[Title/Abstract] OR "integrat*"[Title/Abstract] OR "Problem-based learning"[Title/Abstract] OR "Independent learning"[Title/Abstract] OR "task-based learning"[Title/Abstract] OR "Outcome-based education"[Title/Abstract] OR "Outcome-based learning"[Title/Abstract] OR "self-learning"[Title/Abstract] OR "multiprofessional education"[Title/Abstract] OR "OSCE"[Title/Abstract] OR "OSPE"[Title/Abstract] OR "innovat*"[Title/Abstract] OR "novel*"[Title/Abstract]) AND ("education, medical"[MeSH Terms] OR "medical education"[Title/Abstract])	1,31,806
	#5	"india"[Affiliation] OR "india"[MeSH Terms] OR "india"[Title/Abstract]	9,32,304
	#6	("students, medical"[MeSH Terms] OR "student*"[Title/Abstract] OR "undergraduate*"[Title/Abstract] OR "post graduate*"[Title/Abstract] OR "postgraduate*"[Title/Abstract] OR "doctoral"[Title/Abstract] OR "specialit*"[Title/Abstract] OR "specialt*"[Title/Abstract] OR "super specialt*"[Title/Abstract] OR "superspecialt*"[Title/Abstract] OR "super specialit*"[Title/Abstract] OR "facult*"[Title/Abstract] OR "faculty, medical"[MeSH Terms] OR "medical teacher*"[Title/Abstract] OR "interns"[Title/Abstract] OR "CRRI"[Title/Abstract] OR "CMRI"[Title/Abstract] OR "internship"[Title/Abstract] OR "MBBS"[Title/Abstract]) AND (("curricul*"[Title/Abstract] OR "teaching"[Title/Abstract] OR "learning"[Title/Abstract] OR "assessment"[Title/Abstract] OR "evaluation"[Title/Abstract] OR "curriculum"[MeSH Terms] OR "educational strateg*"[Title/Abstract] OR "educational environment"[Title/Abstract] OR "learning environment"[Title/Abstract] OR "student-centred"[Title/Abstract] OR "Continuing Medical Education"[Title/Abstract] OR "education, medical, continuing"[MeSH Terms] OR "faculty development"[Title/Abstract] OR "faculty training*"[Title/Abstract] OR "CISP"[Title/Abstract] OR "DOAP"[Title/Abstract] OR "self-directed learning"[Title/Abstract] OR "small group discussion"[Title/Abstract] OR "integrat*"[Title/Abstract] OR "Problem-based learning"[Title/Abstract] OR "Independent learning"[Title/Abstract] OR "task-based learning"[Title/Abstract] OR "Outcome-based education"[Title/Abstract] OR "Outcome-based learning"[Title/Abstract] OR "self-learning"[Title/Abstract] OR "multiprofessional education"[Title/Abstract] OR "OSCE"[Title/Abstract] OR "OSPE"[Title/Abstract] OR "innovat*"[Title/Abstract] OR "novel*"[Title/Abstract]) AND ("education, medical"[MeSH Terms] OR "medical education"[Title/Abstract])) AND ("india"[Affiliation] OR "india"[MeSH Terms] OR "india"[Title/Abstract])	1,841

Database	No	Search Query	Results
	#7	(("students, medical"[MeSH Terms] OR "student*"[Title/Abstract] OR "undergraduate*"[Title/Abstract] OR "post graduate*"[Title/Abstract] OR "postgraduate*"[Title/Abstract] OR "doctoral"[Title/Abstract] OR "specialit*"[Title/Abstract] OR "specialt*"[Title/Abstract] OR "super specialt*"[Title/Abstract] OR "superspecialt*"[Title/Abstract] OR "super specialit*"[Title/Abstract] OR "facult*"[Title/Abstract] OR "faculty, medical"[MeSH Terms] OR "medical teacher*"[Title/Abstract] OR "interns"[Title/Abstract] OR "CRRI"[Title/Abstract] OR "CMRI"[Title/Abstract] OR "internship"[Title/Abstract] OR "MBBS"[Title/Abstract]) AND (("curricul*"[Title/Abstract] OR "teaching"[Title/Abstract] OR "learning"[Title/Abstract] OR "assessment"[Title/Abstract] OR "evaluation"[Title/Abstract] OR "curriculum"[MeSH Terms] OR "educational strateg*"[Title/Abstract] OR "educational environment"[Title/Abstract] OR "learning environment"[Title/Abstract] OR "student-centred"[Title/Abstract] OR "Continuing Medical Education"[Title/Abstract] OR "education, medical, continuing"[MeSH Terms] OR "faculty development"[Title/Abstract] OR "faculty training*"[Title/Abstract] OR "CISP"[Title/Abstract] OR "DOAP"[Title/Abstract] OR "self-directed learning"[Title/Abstract] OR "small group discussion"[Title/Abstract] OR "integrat*"[Title/Abstract] OR "Problem-based learning"[Title/Abstract] OR "Independent learning"[Title/Abstract] OR "task-based learning"[Title/Abstract] OR "Outcome-based education"[Title/Abstract] OR "Outcome-based learning"[Title/Abstract] OR "self-learning"[Title/Abstract] OR "multiprofessional education"[Title/Abstract] OR "OSCE"[Title/Abstract] OR "OSPE"[Title/Abstract] OR "innovat*"[Title/Abstract] OR "novel*"[Title/Abstract]) AND ("education, medical"[MeSH Terms] OR "medical education"[Title/Abstract])) AND ("india"[Affiliation] OR "india"[MeSH Terms] OR "india"[Title/Abstract])) AND (english[Filter])	1,841
	#8	(("students, medical"[MeSH Terms] OR "student*"[Title/Abstract] OR "undergraduate*"[Title/Abstract] OR "post graduate*"[Title/Abstract] OR "postgraduate*"[Title/Abstract] OR "doctoral"[Title/Abstract] OR "specialit*"[Title/Abstract] OR "specialt*"[Title/Abstract] OR "super specialt*"[Title/Abstract] OR "superspecialt*"[Title/Abstract] OR "super specialit*"[Title/Abstract] OR "facult*"[Title/Abstract] OR "faculty, medical"[MeSH Terms] OR "medical teacher*"[Title/Abstract] OR "interns"[Title/Abstract] OR "CRRI"[Title/Abstract] OR "CMRI"[Title/Abstract] OR "internship"[Title/Abstract] OR "MBBS"[Title/Abstract]) AND (("curricul*"[Title/Abstract] OR "teaching"[Title/Abstract] OR "learning"[Title/Abstract] OR "assessment"[Title/Abstract] OR "evaluation"[Title/Abstract] OR "curriculum"[MeSH Terms] OR "educational strateg*"[Title/Abstract] OR "educational environment"[Title/Abstract] OR "learning environment"[Title/Abstract] OR "student-centred"[Title/Abstract] OR "Continuing Medical Education"[Title/Abstract] OR "education, medical, continuing"[MeSH Terms] OR "faculty development"[Title/Abstract] OR "faculty training*"[Title/Abstract] OR "CISP"[Title/Abstract] OR "DOAP"[Title/Abstract] OR "self-directed learning"[Title/Abstract] OR "small group discussion"[Title/Abstract] OR "integrat*"[Title/Abstract] OR "Problem-based learning"[Title/Abstract] OR "Independent learning"[Title/Abstract] OR "task-based learning"[Title/Abstract] OR "Outcome-based education"[Title/Abstract] OR "Outcome-based learning"[Title/Abstract] OR "self-learning"[Title/Abstract] OR "multiprofessional education"[Title/Abstract] OR "OSCE"[Title/Abstract] OR "OSPE"[Title/Abstract] OR "innovat*"[Title/Abstract] OR "novel*"[Title/Abstract]) AND ("education, medical"[MeSH Terms] OR "medical education"[Title/Abstract])) AND ("india"[Affiliation] OR "india"[MeSH Terms] OR "india"[Title/Abstract])) AND ((humans[Filter]) AND (english[Filter]))	994
Embase			
	#1	student*':ti,ab,kw OR 'undergraduate*':ti,ab,kw OR 'post graduate*':ti,ab,kw OR 'postgraduate*':ti,ab,kw OR 'doctoral':ti,ab,kw OR 'specialit*':ti,ab,kw OR 'specialt*':ti,ab,kw OR 'super specialt*':ti,ab,kw OR 'superspecialt*':ti,ab,kw OR 'super specialit*':ti,ab,kw OR 'facult*':ti,ab,kw OR 'medical teacher*':ti,ab,kw OR 'interns':ti,ab,kw OR 'crri':ti,ab,kw OR 'cmri':ti,ab,kw OR 'internship':ti,ab,kw OR 'mbbs':ti,ab,kw OR 'medical student'/de OR 'internship'/de	861759
	#2	'curricul*':ti,ab,kw OR 'teaching':ti,ab,kw OR 'learning':ti,ab,kw OR 'assessment':ti,ab,kw OR 'evaluation':ti,ab,kw OR 'educational strateg*':ti,ab,kw OR 'educational environment':ti,ab,kw OR 'learning environment':ti,ab,kw OR 'student-centred':ti,ab,kw OR 'continuing medical education':ti,ab,kw OR 'faculty development':ti,ab,kw OR 'faculty training*':ti,ab,kw OR 'cisp':ti,ab,kw OR 'doap':ti,ab,kw OR 'self-directed learning':ti,ab,kw OR 'small group discussion':ti,ab,kw OR 'integrat*':ti,ab,kw OR 'problem-based learning':ti,ab,kw OR 'independent learning':ti,ab,kw OR 'task-based learning':ti,ab,kw OR 'outcome-based education':ti,ab,kw OR 'outcome-based learning':ti,ab,kw OR 'self-learning':ti,ab,kw OR 'multiprofessional education':ti,ab,kw OR 'osce':ti,ab,kw OR 'ospe':ti,ab,kw OR 'innovat*':ti,ab,kw OR 'novel*':ti,ab,kw OR 'curriculum'/de OR 'continuing medical education'/de	8585011
	#3	'medical education':ti,ab,kw OR 'medical education'/de	322843
	#4	'india'/de OR india:ab,kw,ti,ca	1171606
	#5	#2 AND #3	138764
	#6	#1 AND #4 AND #5	2843
	#7	#1 AND #4 AND #5 AND [humans]/lim AND [english]/lim	2443

Database	No	Search Query	Results
Web of Science			
	#1	TS= (“student*” OR “undergraduate*” OR “post graduate*” OR “postgraduate*” OR “doctoral” OR “specialit*” OR “specialt*” OR “super specialt*” OR “superspecialt*” OR “super specialit*” OR “facult*” OR “medical teacher*” OR “interns” OR “CRRI” OR “CMRI” OR “internship” OR “MBBS”)	549364
	#2	TS= (“curricul*” OR “teaching” OR “learning” OR “assessment” OR “evaluation” OR “educational strateg*” OR “educational environment” OR “learning environment” OR “student-centred” OR “Continuing Medical Education” OR “faculty development” OR “faculty training*” OR “CISP” OR “DOAP” OR “self-directed learning” OR “small group discussion” OR “integrat*” OR “Problem-based learning” OR “Independent learning” OR “task-based learning” OR “Outcome-based education” OR “Outcome-based learning” OR “self-learning” OR “multiprofessional education” OR “OSCE” OR “OSPE” OR “innovat*” OR “novel*”)	9484187
	#3	TS= (“medical education”)	56562
	#4	#3 AND #2	36225
	#5	TS=(India) OR CU=(India)	2139014
	#6	#1 AND #4 AND #5	435
	#7	#1 AND #4 AND #5 and English (Languages)	434
Cochrane Library			
	#1	(“student” OR “undergraduate” OR “post graduate” OR “postgraduate” OR “doctoral” OR “speciality” OR “specialty” OR “super specialty” OR “superspecialty” OR “super speciality” OR “faculty” OR “medical teacher” OR “interns” OR “CRRI” OR “CMRI” OR “internship” OR “MBBS”):ti,ab,kw	47505
	#2	MeSH descriptor: [Students, Medical] explode all trees	2036
	#3	MeSH descriptor: [Faculty, Medical] explode all trees	142
	#4	#1 OR #2 OR #3	47893
	#5	(“curriculum” OR “teaching” OR “learning” OR “assessment” OR “evaluation” OR “educational strategy” OR “educational environment” OR “learning environment” OR “student-centred” OR “Continuing Medical Education” OR “education, medical, continuing” OR “faculty development” OR “faculty training” OR “CISP” OR “DOAP” OR “self-directed learning” OR “small group discussion” OR “integrated” OR “Problem-based learning” OR “Independent learning” OR “task-based learning” OR “Outcome-based education” OR “Outcome-based learning” OR “self-learning” OR “multiprofessional education” OR “OSCE” OR “OSPE” OR “innovative” OR “novel”):ti,ab,kw	652804
	#6	MeSH descriptor: [Curriculum] explode all trees	2904
	#7	MeSH descriptor: [Education, Medical, Continuing] explode all trees	875
	#8	#5 OR #6 OR #7	652838
	#9	MeSH descriptor: [Education, Medical] explode all trees	4936
	#10	(“medical education”):ti,ab,kw	4048
	#11	#9 OR #10	7791
	#12	#8 AND #11	6345
	#13	MeSH descriptor: [India] explode all trees	3568
	#14	(India):ti,ab,kw	14472
	#15	#13 OR #14	14472
	#16	#4 AND #12 AND #15	51
Scopus			
	#1	TITLE-ABS-KEY(“student*” OR “undergraduate*” OR “post graduate*” OR “postgraduate*” OR “doctoral” OR “specialit*” OR “specialt*” OR “super specialt*” OR “superspecialt*” OR “super specialit*” OR “facult*” OR “medical teacher*” OR “interns” OR “CRRI” OR “CMRI” OR “internship” OR “MBBS”)	2,407,426
	#2	TITLE-ABS-KEY(“curricul*” OR “teaching” OR “learning” OR “assessment” OR “evaluation” OR “educational strateg*” OR “educational environment” OR “learning environment” OR “student-centred” OR “Continuing Medical Education” OR “education, medical, continuing” OR “faculty development” OR “faculty training*” OR “CISP” OR “DOAP” OR “self-directed learning” OR “small group discussion” OR “integrat*” OR “Problem-based learning” OR “Independent learning” OR “task-based learning” OR “Outcome-based education” OR “Outcome-based learning” OR “self-learning” OR “multiprofessional education” OR “OSCE” OR “OSPE” OR “innovat*” OR “novel*”)	21,754,927
	#3	TITLE-ABS-KEY(“medical education”)	349,194

Database	No	Search Query	Results
	#4	(TITLE-ABS-KEY("curricul*"OR"teaching"OR"learning"OR"assessment"OR"e valuation"OR"educational strateg*"OR"educational environment"OR"learning environment"OR"student-centred"OR"Continuing Medical Education"OR"education, medical, continuing"OR"faculty development"OR"faculty training*"OR"CISP"OR"DO AP"OR"self-directed learning"OR"small group discussion"OR"integrat*"OR"Problem-based learning"OR"Independent learning"OR"task-based learning"OR"Outcome-based education"OR"Outcome-based learning"OR"self-learning"OR"multiprofessional education "OR"OSCE"OR"OSPE"OR"innovat*"OR"novel*"))AND(TITLE-ABS-KEY("medical educa-tion"))	192,014
	#5	(TITLE-ABS-KEY(india)ORAFFILCOUNTRY(India))	4,253,774
	#6	(TITLE-ABS-KEY("student*"OR"undergraduate*"OR"post graduate*"OR"postgrad uate*"OR"doctoral"OR"specialit*"OR"specialt*"OR"super specialt*"OR"superspeci alt*"OR"super specialit*"OR"facult*"OR"medical teacher*"OR"interns"OR"CRRI"O R"CMRI"OR"internship"OR"MBBS"))AND((TITLE-ABS-KEY("medical education")) AND(TITLE-ABS-KEY("curricul*"OR"teaching"OR"learning"OR"assessment"OR "evaluation"OR"educational strateg*"OR"educational environment"OR"learning environment"OR"student-centred"OR"Continuing Medical Education"OR"education, medical, continuing"OR"faculty development"OR"faculty training*"OR"CISP"OR"DO AP"OR"self-directed learning"OR"small group discussion"OR"integrat*"OR"Problem-based learning"OR"Independent learning"OR"task-based learning"OR"Outcome-based education"OR"Outcome-based learning"OR"self-learning"OR"multiprofessional educ ation"OR"OSCE"OR"OSPE"OR"innovat*"OR"novel*")))AND((TITLE-ABS-KEY(india) ORAFFILCOUNTRY(India)))AND(LIMIT-TO(LANGUAGE,"English"))	3,220

Supplementary Table S2: Department/Subjects of the studies included in the scoping review as per the study population

	Overall (N=607) n (%)	MBBS (N=534) n (%)	PG/SS (N=65) n (%)	Faculty (N=34) n (%)
Pre-clinical				
Physiology	118 (19.4)	113 (21.1)	5 (7.7)	4 (11.8)
Anatomy	67 (11.0)	67 (12.5)		
Biochemistry	64 (10.5)	62 (11.8)	1 (1.5)	5 (14.7)
Para-clinical				
Pharmacology	74 (12.2)	72 (13.4)	3 (4.6)	1 (2.9)
Pathology	27 (4.4)	27 (5)		2 (5.9)
Microbiology	18 (3.0)	18 (3.4)	1 (1.5)	
FMT	17 (2.8)	15 (2.8)	1 (1.5)	1 (2.9)
Clinical				
Community Medicine	42 (6.9)	39 (7.3)	3 (4.6)	3 (8.8)
Pediatrics	20 (3.3)	14 (2.6)	7 (10.8)	3 (8.8)
General Surgery	20 (3.3)	11 (2.1)	8 (12.3)	1 (2.9)
Internal Medicine	18 (3.0)	15 (2.8)	3 (4.6)	1 (2.9)
O&G	8 (1.3)	7 (1.3)	1 (1.5)	
Ophthalmology	8 (1.3)	3 (0.6)	5 (7.7)	1 (2.9)
Dermatology	8 (1.3)	8 (1.5)		
Orthopedics	7 (1.2)	4 (0.7)	2 (3.1)	
Emergency Medicine	6 (1.0)	4 (0.7)	2 (3.1)	
Anesthesiology	6 (1.0)	2 (0.4)	4 (6.2)	
Psychiatry	4 (0.7)	4 (0.7)		
Otorhinolaryngology (ENT)	10 (1.6)	9 (1.7)	1 (1.5)	
Neurosurgery	3 (0.5)		3 (4.6)	
Transfusion Medicine	3 (0.5)	2 (0.4)	1 (1.5)	
Clinical departments	3 (0.5)	1	3 (4.6)	
All/Multi departments	5 (0.8)	2 (0.4)	4 (6.2)	1 (2.9)
Research Methodology	2 (0.3)	2 (0.4)		1 (2.9)
Medical Education	4 (0.7)	2 (0.4)	1 (1.5)	3 (8.8)
AETCOM	2 (0.3)	2 (0.4)		
Others*	11 (1.8)	3 (0.6)	3 (4.6)	
No information	67 (11.0)	58 (10.8)	3 (4.6)	7 (20.6)

**Radiology (1), Vitreous & Retina (1), Neonatology (1), Urology (1), Critical Care Medicine (1), Basic course workshop for MET (1), Foundation course (1), Pre- and paraclinical departments (1), Gastroenterology (1), Trauma and First Aid (1), Physical Medicine and Rehabilitation (1).*

Supplementary Table S3: Outcomes assessed and Kirkpatrick's levels of learning in the studies included in the scoping review (N=607)

	Overall (N=607) n (%)	**MBBS (N=534) n (%)**	**PG/SS (N=65) n (%)**	**Faculty (N=34) n (%)**
Outcomes				
Reaction	545 (89.8)	480 (89.9)	58 (89.2)	33 (97)
Knowledge	562 (92.6)	495 (92.7)	57 (87.7)	34 (100)
Skill	113 (18.6)	85 (15.7)	29 (44.6)	4 (11.8)
Attitude	4 (0.7)	3 (0.6)	1 (1.5)	
Behaviour	4 (0.7)	1 (0.2)	1 (1.5)	1 (2.9)
Practices	3 (0.2)	0 (0)	1 (1.5)	
Patient outcomes	1 (0.2)	1 (0.2)		
Kirkpatrick's levels				
I (Reaction- Feedback, Participant satisfaction)	545 (89.8)	480 (89.9)	58 (89.2)	33 (97)
II (Learning- Acquisition of knowledge, attitude & skills)	570 (93.9)	501 (94.4)	61 (93.9)	34 (100)
Level I & II	513 (84.5)	447 (83.7)	54 (83.1)	33 (97)
III (Behavior- Observation of on job application)	9 (1.5)	1 (0.2)	2 (3.1)	1 (2.9)
IV (Results- Impact on patient outcomes & organisational goals)	1 (0.2)	1 (0.2)		