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Comparing the seminar-case learning and lecture-based learning models in medical education: a meta-analysis of randomized controlled trials

Jicheng Lou[2,3] and Feng Guo[1*]

Abstract

Background The seminar-case learning (SCL) model is a case-oriented teaching model, characterized by communication, interaction and mutual inspiration. This study aimed to investigate the impact of SCL versus lecture-based learning (LBL) on medical education outcomes.

Methods A comprehensive search was conducted across seven distinct databases, covering the period from their inception until June 2024. Article selection was independently performed by two authors, adhering to predefined inclusion and exclusion criteria. Randomized controlled trials (RCTs) that evaluated the effects of the SCL model in comparison to the LBL model were included. The meta-analysis was executed using RevMan 5.4 software.

Results Sixteen RCTs involving 956 medical students were included in the meta-analysis. The implementation of the SCL model significantly improved theoretical knowledge scores (MD 5.21, 95% CI 3.27–7.16; $p < 0.00001$), case analysis scores (MD 4.12, 95% CI 2.13–6.11; $p < 0.0001$) and skill scores (MD 5.37, 95% CI 3.53–7.21; $p < 0.00001$). Furthermore, the SCL model significantly improved teaching ability, including learning interest, self-learning ability and clinical thinking ability. Despite experiencing a heightened sense of burden, students in the SCL group reported greater satisfaction compared to their counterparts in the LBL group.

Conclusions In comparison to the LBL model, the SCL model significantly improved students' outcomes. In addition, the SCL model could promote the cultivation of the clinical thinking and assist students in bridging the gap between theoretical knowledge and clinical practice.

Keywords Seminar-case learning, Seminar, Case-based learning, Lecture-based learning

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Introduction

The traditional lecture-based learning (LBL) model, which is a teacher-centered method with lectures, is a primary teaching method in medical education [1]. The LBL model usually involves a transfer of theoretical knowledge from medical textbooks to students, and this method fails to cultivate students' independent thinking or to provide practical applications of theoretical knowledge [2]. This medical education model could result in a disconnection between theory and clinical practice [3]. Moreover, many diseases often have complex or atypical manifestations. It is crucial to cultivate doctors with a deep understanding of theoretical knowledge and strong skills in clinical practice [4]. Therefore, new teaching models are urgently needed to improve the efficacy of clinical teaching.

The seminar-case learning model (SCL), a new teaching method, has been reported in the literature in recent years. The SCL model is a combination of seminar and case-based learning, and it innovative integrates the efficient communication of seminar learning and the clinical thinking of case-based learning. Seminar learning is a teaching method in which students work together in small groups to discuss specific topics or questions under the guidance of teachers [5, 6]. This teaching method emphasizes communication between students and teachers, mobilizing students' learning enthusiasm and cultivating their divergent thinking [7]. Case-based learning (CBL) is also referred to as case study teaching and case method learning [8]. CBL could provide comprehensive information about real cases, which can stimulate students' interest and promote active analysis [9, 10].

In SCL model, the assisted teacher selects a typical authentic case and sends the anonymized patient's information to students via a chat software group prior to class. Students are expected to take the initiative to preview the course and independently prepare responses to questions raised by teachers [11]. During class, the lead teacher gives a brief lecture to illustrate the main points of disease, of which the content was a simplified version of traditional teaching. Subsequently, the teacher introduces the selected case, prompting students to summarize the disease characteristics, analyze the results of the patient's clinical auxiliary examinations in groups, and respond to the posed questions in advance. In a seminar setting, students engage in idea exchange and open discussion with peers and instructors. The leading teacher ensures thorough discussion of the case and questions, intervening only to clarify complex or contentious topics as necessary. The exchange of ideas could deepen students' understanding and improve their memory of theoretical knowledge. Finally, the leading teacher summarizes the clinical characteristics of the case, extrapolates the case to the broader context of the disease, and shares experiential insights related to the disease. The SCL method represents an attempt to replace traditional lecture-based teaching, offering a more structured and consistent pedagogical approach [11, 12].

Recently, the SCL model has been implemented in medical education with the objective of fostering active student participation, facilitating analytical thinking, and promoting open discussion of clinical cases. This approach seeks to bridge the gap between theoretical medical knowledge and practical clinical application. However, there was no high-quality evidence like a systematic review or meta-analysis to summarize the characteristics of SCL. This systematic review and meta-analysis aimed to compare the teaching efficacy of SCL and LBL in medical education.

Methods

This meta-analysis was conducted on the basis of the Preferred Reporting Items for Systematic Reviews and Meta-Analysis checklist guidelines published in 2020 (PRISMA Checklist). All the data were extracted from previously published literature; thus, ethical approval and patient consent were not necessary. This meta-analysis was registered in the PROSPERO database (CRD42024581198). The experimental group is SCL, while the control group is LBL.

Search strategy

Two authors independently searched electronic databases, including PubMed, the Cochrane Library, Embase and the Web of Science, from their inception until June 2024. Data were also retrieved from Chinese databases, including the China National Knowledge Infrastructure (CNKI), WanFang Data, and Chinese Biomedical Literature Database (CBM). The retrieval strategy involves conducting a search of titles and abstracts. And the search strategy is presented in Supplementary Appendix 1. The core search terms included seminar, seminar-case learning, case-based learning, SCL, CBL, lecture-based learning, LBL, traditional teaching, and randomized. The publication languages were restricted to English and Chinese.

Selection criteria

This meta-analysis included all the RCTs investigating the effects of the SCL model versus the LBL model in the teaching of medical students. To find all possible relevant studies, the references of the included studies were manually searched and inspected.

The inclusion criteria were as follows: randomized controlled trials, undergraduate or postgraduate students as the subjects of the study, and studies with

complete and accurate data. The exclusion criteria were as follows: non-original studies, expert opinions, reviews, meeting minutes, no measurement data or insufficient data, duplicate publications, and lack of availability of full-text articles. In case of subjective selection bias, two reviewers required to engage in a discussion and reach a consensus. If the controversy is great, then it is necessary to consult another professional researcher.

Data extraction

The studies were managed via EndNote 20 software. Two authors selected the articles and independently extracted the data via a standardized form. The standardized form included the following information: authors, publication year, country, study type, sample size, research title, student characteristics, course characteristics, and outcomes. We selected the academic record as the primary outcome, because it could directly reflect the teaching efficacy. The primary outcomes of the meta-analysis included theoretical knowledge scores, case analysis scores and skill scores. The secondary outcomes were assessments of teaching effects, including learning interest, self-learning ability, clinical thinking ability, satisfaction with teaching methods, and the burden of study.

Assessment of study quality

The Cochrane Collaboration's risk of bias tools were used for assessing the risk of bias of each eligible RCT by two independent reviewers [13]. Any discrepancy was resolved through discussion until a consensus was reached.

Statistical analysis

The meta-analysis was performed via RevMan5.4 software. For dichotomous variables, the relative risk (RR) and 95% confidence interval (CI) were calculated via the Mantel–Haenszel test (M-H). For continuous variables, the weighted mean difference (MD) and 95% CI were calculated via the inverse-variance test (IV). The heterogeneity of each included study was tested via the χ^2 test. The random-effects model was used for meta-analysis when $I^2 > 50\%$; otherwise, the fixed-effects model was used [14]. Sensitivity analysis was employed to investigate possible sources of high heterogeneity ($I^2 > 50\%$), and the methods employed included a methodological transition between fixed-effect and random-effect models [15]. A funnel plot was used to assess publication bias only if the number of studies was 10 or more. $P < 0.05$ was considered statistically significant.

Results

Search results and studies selection

A total of 1459 articles were identified in the initial search. After duplicates and records marked as ineligible by automation tools were removed, the titles and abstracts of 1009 unique records were screened. A total of 66 studies were retrieved for further full-text evaluation, and 16 studies were selected for meta-analysis [16–31]. The Prisma 2020 flow diagram of the literature screening process is depicted in Fig. 1.

Basic characteristics

A total of 956 medical students in sixteen RCTs were included in the meta-analysis. A total of 482 medical students who accepted the SCL model composed the experimental group, and the other 474 students who accepted the LBL model composed the control group. All the studies were published between 2014 and 2024. Two of the studies were published in English [21, 24], and the remaining 14 studies were published in Chinese. The basic characteristics of all the eligible studies are shown in Table 1. The medical courses in the included studies were from the disciplines of gastroenterology, oncology, nephrology, surgery, medical imageology, neurology, rehabilitation medicine, otorhinolaryngology, emergency medicine and dermatology.

Quality assessment of the included literature

The risk of bias of the included studies is shown in Fig. 2. Ten studies had a low risk according to the random sequence generation method, whereas the other six studies had a high risk. Six studies did not report allocation concealment and were judged as having an unclear risk of bias. Teachers had to implement different teaching methods, which meant that double-blinding was not possible. All studies had a low risk of bias in the outcome assessment. All studies adopted complete outcomes, and no selective reporting was conducted. Other bias was unclear.

Meta-analysis results of theoretical knowledge

Thirteen studies investigated the theoretical knowledge scores of 814 students, including 412 students in the experimental group and 402 students in the control group. Significant heterogeneity was found among the studies ($I^2 = 96\%$); thus, the random effects model was used for the meta-analysis. Compared with the LBL model, the SCL model was associated with higher theoretical knowledge scores (MD 5.21, 95% CI 3.27–7.16; $p < 0.00001$) (Fig. 3).

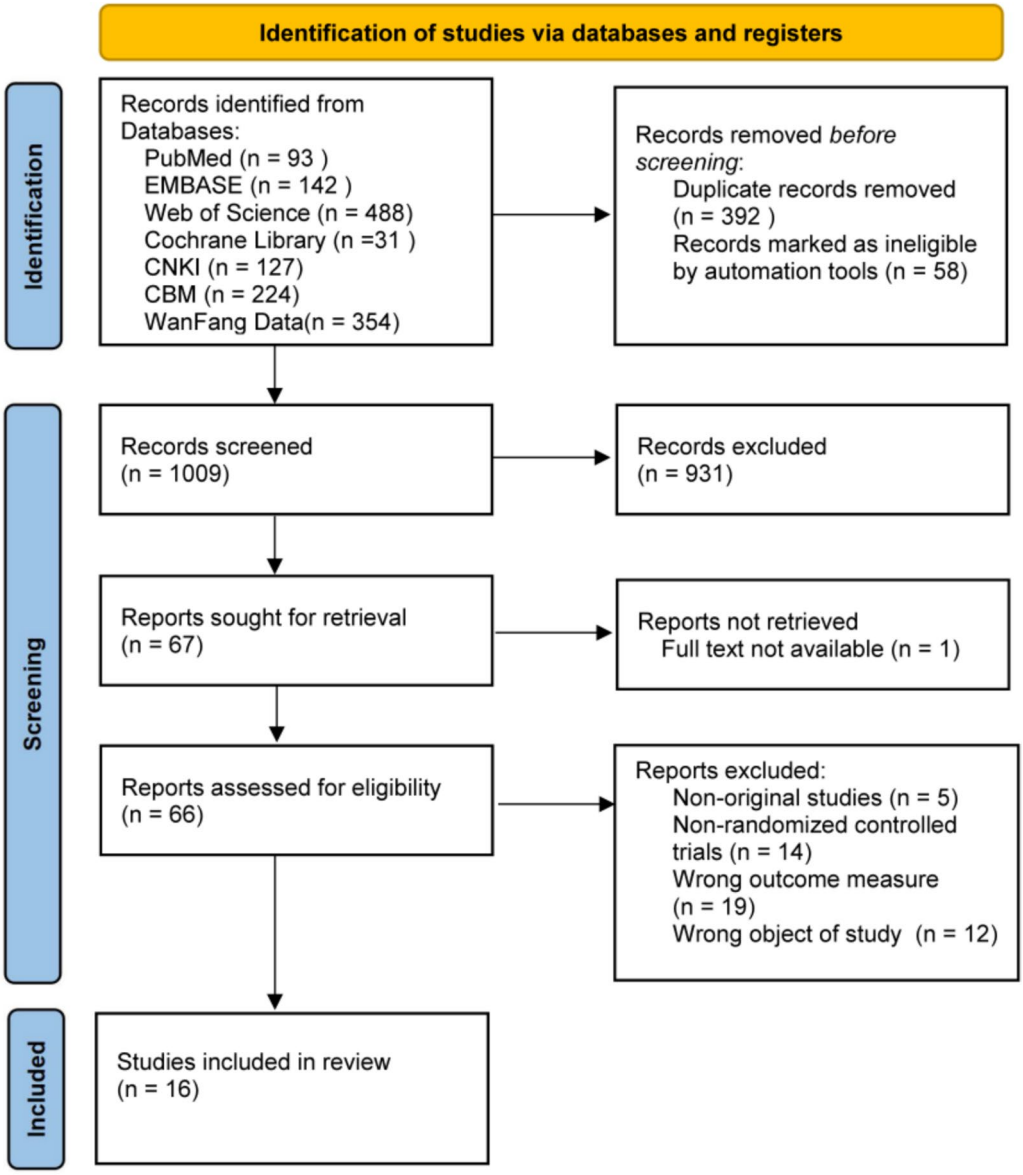

Fig. 1 PRISMA flow diagram of the literature search

Results of the meta-analysis of clinical competence

The clinical competence evaluation included a case analysis test and a skill test. Eight studies reported case analysis scores, including 256 students in the experimental group and 248 students in the control group. Compared with the LBL model, the SCL model was associated with higher case analysis scores (MD 4.12, 95% CI 2.13–6.11; $p < 0.0001$; $I^2 = 96\%$) (Fig. 4). Ten studies reported skill scores, including 281 students in the experimental group and 281 students in the control group. Compared with the LBL model, the SCL model was associated with higher skill scores (MD 5.37, 95% CI 3.53–7.21; $p < 0.00001$; $I^2 = 95\%$) (Fig. 5).

Meta-analysis results of teaching effects and student satisfaction

The assessment of teaching effects included improvement in learning interest, improvement in self-learning ability, and cultivation of clinical thinking ability. The number of studies available for learning interest, self-learning ability and clinical thinking ability was five, three and four, respectively. Compared with the LBL model, the SCL model significantly improved the teaching effects. The details of the meta-analysis results are shown in Fig. 6. Five studies reported data on student satisfaction. The results revealed that students in the SCL group were more satisfied than were those in

Table 1 The detailed baseline characteristics of all included studies

Study	Publication time	No. of SCL	No. of LBL	students	Course category	outcomes
Huang [16]	2014	40	40	Undergraduate	Nephrology	1,2
Tian [17]	2016	25	25	Undergraduate	General surgery	3
Lyu [18]	2019	24	24	Undergraduate	Otorhinolaryngology	1,3,8
Wang [19]	2020	30	30	Undergraduate	Rehabilitation medicine	1,2
Zhang [20]	2020	30	30	Undergraduate	Neurology	1,2,4,5,7
Li [21]	2021	50	42	Postgraduate	Gastroenterology	1,2,4,5,6,7
Wang [22]	2021	30	30	Undergraduate	Oncology	2,3
Xiong [23]	2021	25	25	Undergraduate	Nephrology	1,3,8
Yang [24]	2021	20	20	Undergraduate	General surgery	1,2,3,4,5,6,8
Li [25]	2022	31	31	Undergraduate	Neurology	1,2,4,6,7
Dai [26]	2023	20	20	Undergraduate	Neurosurgery	2,3
LiuH [27]	2023	51	51	Undergraduate	Thoracic surgery	1,3
LiuX [28]	2023	31	31	Undergraduate	Emergency medicine	1,3
Sun [29]	2023	32	32	Undergraduate	Dermatology	1,3,4,6,8
Zhao [30]	2023	23	23	Undergraduate	Medical imageology	1,3,8
Li [31]	2024	20	20	Undergraduate	Medical imageology	1

No.: number; 1. theoretical knowledge scores; 2. case analysis test scores; 3. skill scores; 4. learning interest; 5. self-learning ability; 6. clinical thinking ability; 7. occupation of more time and greater burden; 8. student satisfaction

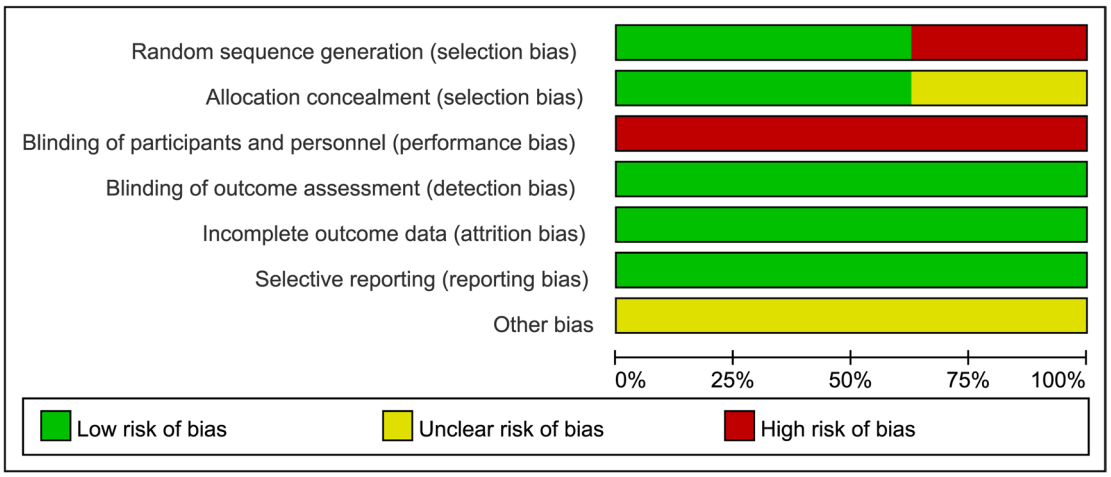

Fig. 2 Risk of bias graph as percentages for all included studies

the LBL group (RR 1.38, 95% CI 1.14–1.69; $p < 0.001$; $I^2 = 64\%$) (Fig. 7). Three studies reported data on the burden of learning. The meta-analysis results revealed that students in the SCL group felt a greater sense of burden than their counterparts in the LBL group (RR 2.59, 95% CI 1.82–3.69; $p < 0.00001$; $I^2 = 46\%$) (Fig. 8).

Sensitivity analysis

High heterogeneity was observed in several meta-analyses, and sensitivity analysis was conducted to assess the reliability of the results. After the statistical method was changed and the meta-analysis was recalculated, the effects did not change in theoretical knowledge scores (MD 4.49, 95% CI 4.12–4.86; $p < 0.00001$), case analysis scores (MD 2.32, 95% CI 2.05–2.60; $p < 0.00001$), skill scores (MD 3.21, 95% CI 2.92–3.50; $p < 0.00001$), self-learning ability (RR 2.36, 95% CI 1.72–3.23; $p < 0.00001$), or student satisfaction (RR 1.45, 95% CI 1.28–1.63; $p < 0.00001$) (Supplemental Appendix 2). The sensitivity analysis revealed the relative stability of the meta-analysis results.

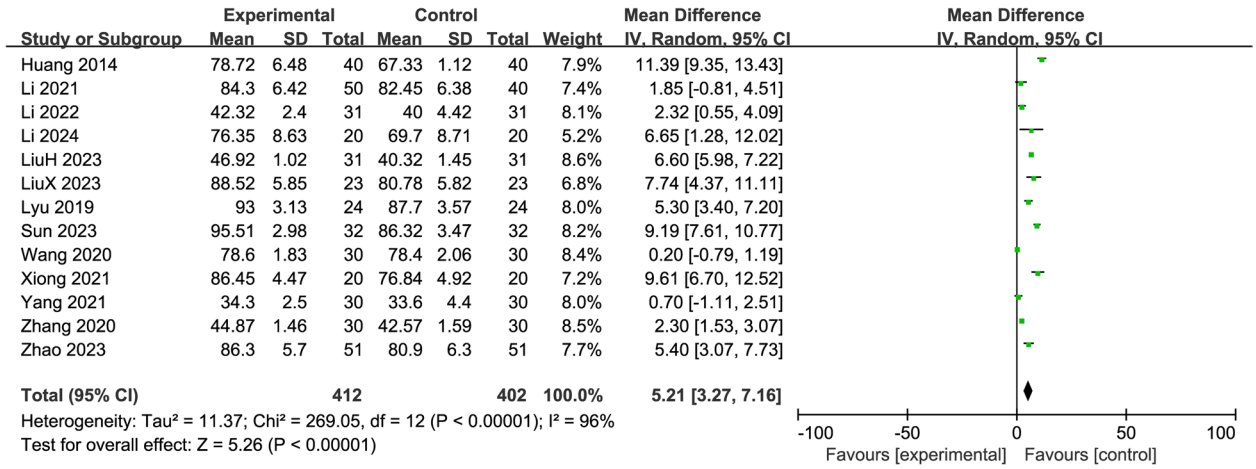

Fig. 3 Forest plot of theoretical knowledge scores

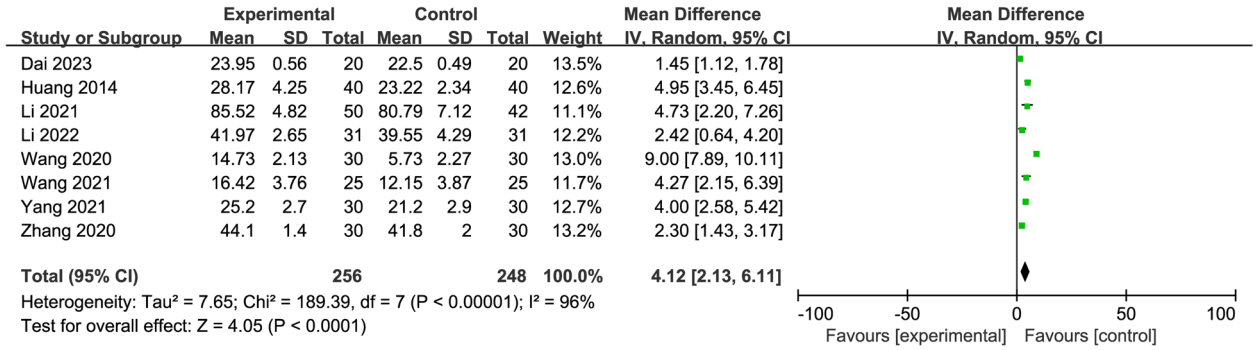

Fig. 4 Forest plot of the case analysis scores

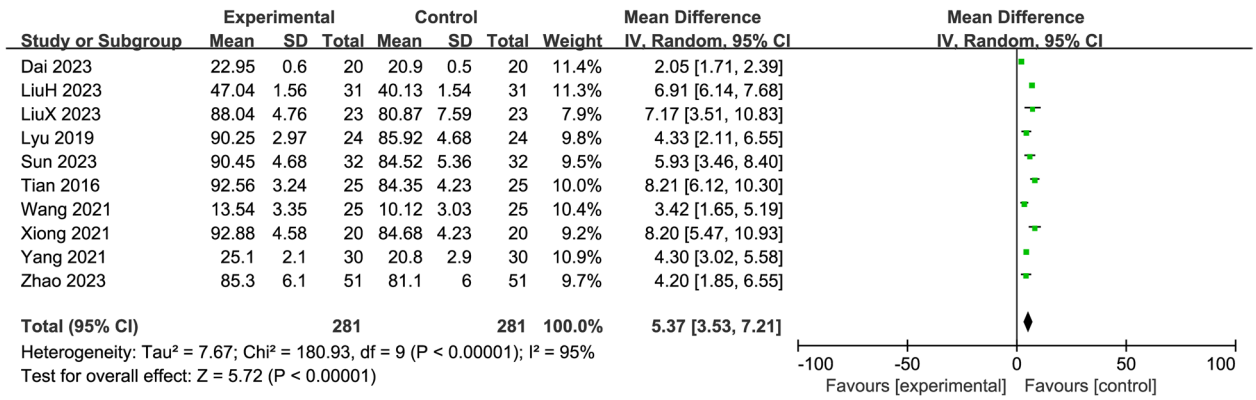

Fig. 5 Forest plot of skill scores

Publication bias

A funnel plot was employed to evaluate publication bias within the meta-analysis of theoretical knowledge and skill scores, given that the number of included studies was ten or more (Fig. 9). The analysis of the funnel plot demonstrated no significant asymmetry, suggesting an absence of discernible publication bias in the aggregated results.

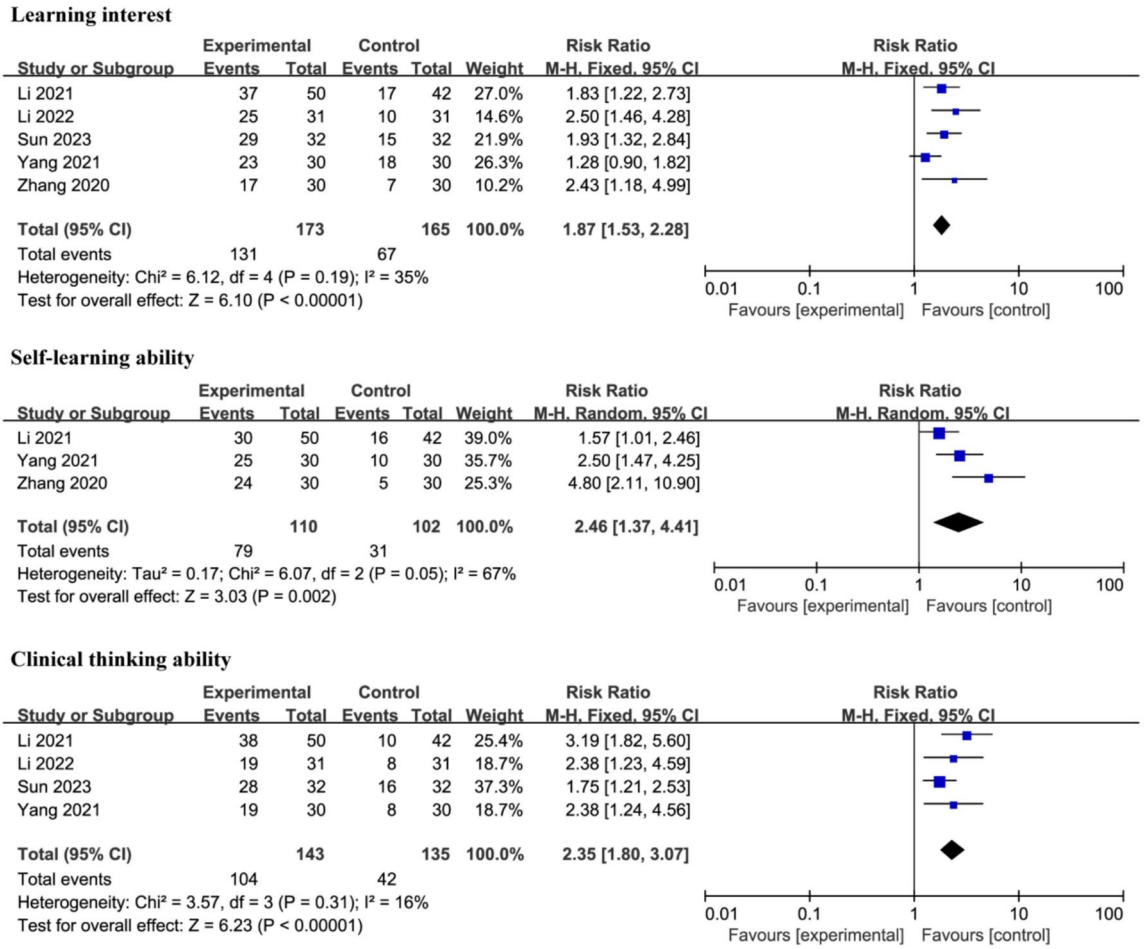

Fig. 6 Forest plot of learning interest, self-learning ability and clinical thinking ability

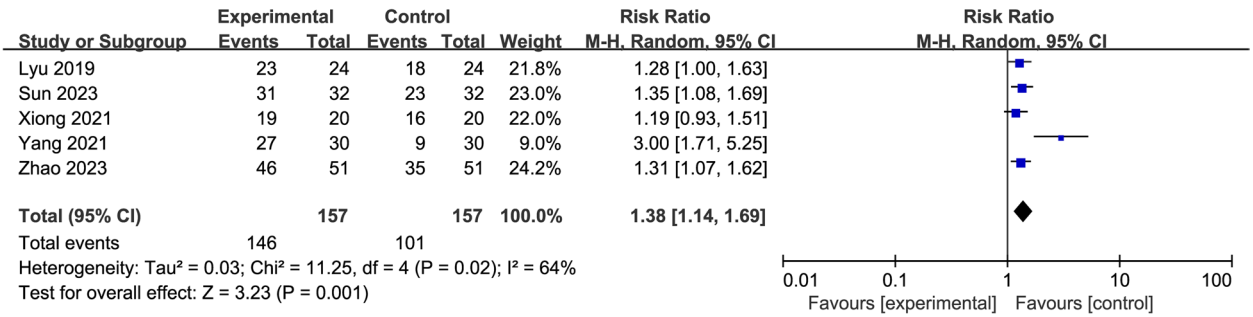

Fig. 7 Forest plot of student satisfaction

Discussion

The lecture-based learning (LBL) model is a traditional teaching model that is characterized by a more didactic approach through utilizing the syllabus and concepts of medical textbooks [24]. However, this teaching model did not cultivate medical students' ability to engage in clinical thinking [2]. The insufficient integration of practical applications with clinical knowledge hinders students' comprehensive understanding of the abstract theoretical concepts in medicine. Consequently, this results in

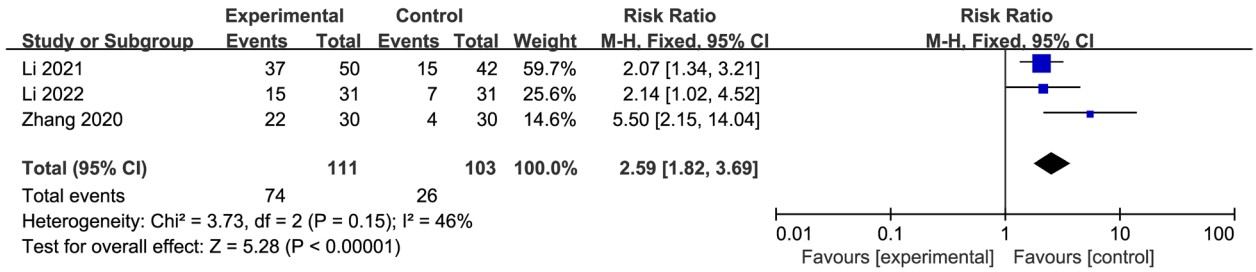

Fig. 8 Forest plot of the burden of learning

diminished enthusiasm for engaging with theoretical content in LBL environments [32]. Owing to the continuous progress of modern medicine and increased demands for medical education, the traditional medical teaching model cannot achieve satisfactory teaching effects [33].

Both seminar learning and case-based learning (CBL) models have been mentioned to be effective in medical education [34]. The seminar-case learning (SCL) model, a combination of seminar learning and CBL, which uses the advantages of both teaching methods, has been reported to be highly effective in medical education in recent years [12]. Through independently reviewing clinical cases, making diagnoses and treatment plans, participating in group consultations and reporting, exchanging ideas and engaging in open discussion with peers and teachers who clarify challenging or controversial topics as needed, students can gain a clearer understanding and deeper insights into the learning content [28, 31]. In this meta-analysis, compared with LBL, SCL significantly improved theoretical knowledge scores, case analysis scores and clinical skill scores. Scores are not only a direct way to assess students' acquisition of knowledge but also a vital parameter for measuring the quality of education.

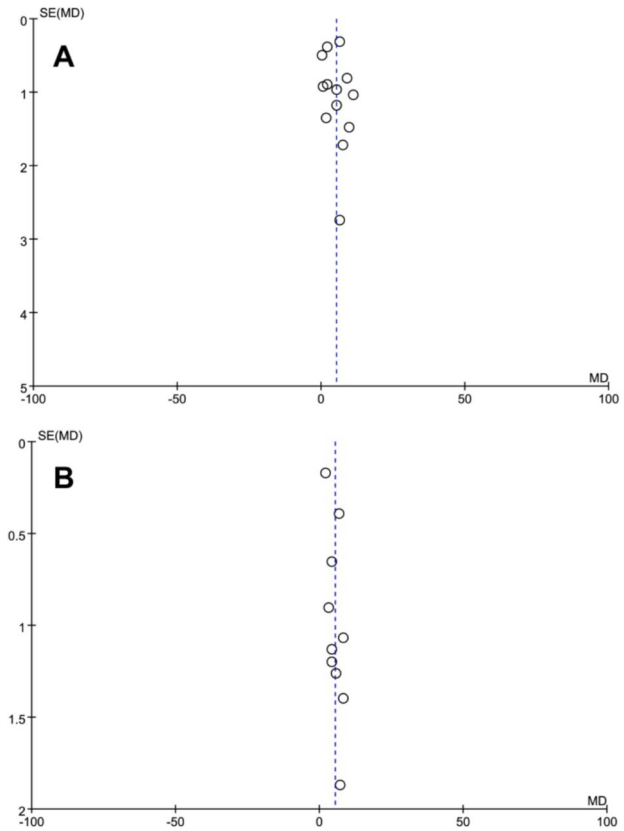

Fig. 9 Funnel plot of knowledge scores (**A**) and skill scores (**B**)

In addition to improving scores, this meta-analysis revealed that, compared with LBL, the SCL model significantly improved teaching effects, including learning interest, self-learning ability and clinical thinking ability. The improvement in learning effects may be due to the following reasons. This is closely related to the implementation process of the SCL model. Firstly, students need to read a clinical case, and they are expected to review literature and clinical guidelines to answer the questions provided by teachers before class, which could increase their learning interest and improve their self-learning ability [21]. Morgan et al. found that the information-seeking process could improve students' literature retrieval ability and increase their knowledge reserves [6]. Secondly, students and teachers engage collaboratively in the entire teaching process, which shifts teachers from the dominant position and allows students to play a more active role. In the seminar teaching method, there is greater focus on the role of student initiative in the teaching process [35]. Thomas et al. considered that the exchange of ideas between students could deepen their understanding and improve their memory of theoretical knowledge in seminar discussions [36]. Thirdly, SCL teaching is based on typical real cases. Yang G et al. affirmed that students could engage fully in the complete patient care process, access complete clinical case data, conduct analyses with real symptoms and examination results, and carry out diagnosis and treatment [37]. This approach could cultivate students' ability for case analysis. At last, seminar discussions can enrich students' understanding of a disease. Details of the physical examination and

clinical procedures are also performed and discussed, which could improve students' medical skill scores [38]. Clinical thinking is developed during the seminar discussion and case analysis. In summary, SCL is beneficial for practical applications of theoretical knowledge.

The results of this meta-analysis revealed that students in the SCL group felt a greater sense of burden than those in the LBL group did. Zhang J et al. reported that the SCL model requires more time from students [20]. They also reported that the main source of the increased burden stemmed from preparation tasks, including literature retrieval and gathering the latest clinical case guidelines. One study stated that this negative learning experience can be improved by selecting relatively simple cases and simplifying the preparation tasks [21]. Although the SCL model may increase the burden of learning, the results of this meta-analysis revealed that students in the SCL group were more satisfied than those in the LBL group were. Li P et al. reported that 70% of experimental students continued to adopt the SCL model [21]. This may be due to the SCL model providing a better classroom atmosphere, greater interaction between teachers and students, and a deeper understanding of theoretical knowledge. Students felt that they could achieve significant progress with this new teaching method [29].

As a new teaching method, SCL still faces many difficulties. For students, this method may be more time-consuming and create a burden due to the preparation work of relevant literature and the latest guidelines of the specific case, which may generate a sense of resistance, which may generate a sense of resistance. Furthermore, the limited ability of some students to retrieve literature may result in inadequate preparation [26]. This negative learning experience may be improved by choosing relatively simpler cases and simplifying the preparation work. Other students may be accustomed to lecture-based education, and they may need more time to adapt to the new teaching method. Certain students lack the ability to express and communicate, which may prevent them from expressing their opinions in seminar discussions [39]. Such students may need more encouragement and communication exercise. The SCL model requires teachers not only to have extensive medical knowledge but also strong teaching skills and experience. Teachers need to allocate additional time to select representative cases, encourage student participation, manage classroom interactions, facilitate discussions, address controversial topics efficiently, and comprehensively cover all learning aspects [24, 30]. In addition, we could not ignore the advantages of the LBL teaching method. From a pragmatic perspective, lectures are frequently used to transmit a large amount of knowledge to a wider audience, which cannot be reached through seminars alone.

Several limitations of this study should be acknowledged: (1) variations in course content, difficulty of examinations, course durations, and teaching skills of the included studies might have led to high heterogeneity; (2) the randomization method was not clear in some included studies, which might have generated selection bias; (3) the included articles varied in quality, which might impact the results of this meta-analysis; (4) The studies included in the meta-analysis focus on short-term outcomes, such as immediate knowledge and skill acquisition, without assessing the long-term retention of knowledge or skills; (5) Due to the limited promotion of this instructional approach, the articles included in the study exhibit regional constraints. Consequently, further implementation across diverse regions is necessary to validate its educational efficacy; and (6) the sample was not large enough in every included study, which might have led to study effect bias. Despite the above limitations, this meta-analysis is helpful with respect to identifying the effectiveness of a new type of teaching method in medical education.

Conclusions

In conclusion, in medical education, the SCL model could effectively improve teaching outcomes including theoretical knowledge scores, case analysis scores and skill scores. In addition, the SCL model could raise students' learning interest, self-learning ability and clinical thinking ability. The implementation of the SCL model may assist students in bridging the gap between theoretical knowledge and clinical practice. However, the SCL model may require additional time and potentially increase the learning burden. As an effective teaching method for medical education, the implementation of the SCL pedagogical approach can be considered for educators.

Abbreviations

SCL	Seminar-case learning
LBL	Lecture-based learning
CBL	Case-based learning
RCT	Randomized controlled trial
MD	Weighted Mean Difference
CIs	Confidence intervals
RR	Relative risk

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12909-025-07041-w.

Supplementary Material 1.

Supplementary Material 2.

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Authors' contributions
LJC worked on project design, data collection and analysis, and manuscript write up. GF worked on project design, data collection and analysis, and manuscript revision. All authors have read and approved the final manuscript. And none conflicts of interest. There's no Funding in this research.

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Data availability
The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
Not applicable because this study is a review article and a meta-analysis.

Competing interests
The authors declare no competing interests.

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