

Application and Effectiveness Analysis of CBL, PBL Combined with SP and EBM Teaching Methods in Clinical Teaching

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1.Introduction

With the ongoing advancements in medical education, cultivating medical students with a strong theoretical foundation, robust clinical practice skills, and critical thinking abilities has become a significant challenge for medical educators. The traditional lecture-based learning (LBL) model positions students as passive recipients of knowledge. While this approach effectively delivers basic medical knowledge, it exhibits notable shortcomings in fostering practical clinical skills, problem-solving abilities, and communication proficiency. In the context of a modern, increasingly complex clinical environment, medical students must not only possess a solid knowledge base but also demonstrate the capacity to adapt to dynamic clinical scenarios and make complex diagnostic and therapeutic decisions.

In recent years, innovative teaching methodologies such as Case-Based Learning (CBL), Problem-Based Learning (PBL), Standardized Patients (SP), and Evidence-Based Medicine (EBM) have garnered increasing attention and are now widely adopted globally. These approaches are recognized for their effectiveness in enhancing students' clinical skills, critical thinking, and independent learning compared to traditional lecture-based teaching methods. CBL emphasizes the use of real or simulated clinical cases to help students bridge the gap between abstract theoretical knowledge and practical clinical application. Through case studies, students simulate diagnostic and therapeutic processes in the classroom, fostering problem analysis and treatment planning abilities.

PBL, driven by problem-solving, encourages students to independently explore and discuss clinical issues. This method promotes active learning and cultivates critical and innovative thinking, particularly in addressing real-world clinical challenges. Similarly, SP-based teaching allows students to engage with standardized patients in near-realistic clinical scenarios, providing opportunities to practice history-taking, physical examinations, and communication skills in a safe, simulated environment. This approach enhances their confidence and competence in real-life clinical settings.

EBM, on the other hand, emphasizes the integration of the latest scientific evidence, clinical expertise, and patient values in medical decision-making. By

engaging in EBM, students learn to locate, appraise, and apply high-quality evidence, improving the rigor and accuracy of clinical decisions.

The combined application of these innovative teaching methodologies leverages their individual strengths to address the limitations of traditional teaching models. For instance, integrating CBL and PBL can enhance critical thinking and problem-solving skills, SP provides dynamic and practical clinical scenarios, and EBM fosters evidence-based thinking to ensure the validity and efficacy of medical decisions. Together, these methods create a comprehensive and interactive learning environment that better prepares students for the complexities of modern clinical practice.

Despite the global adoption of these pedagogical approaches, their effectiveness in specific teaching contexts requires further validation. Notably, there is a lack of systematic research on how to seamlessly integrate these methodologies to leverage their complementary strengths. Additionally, optimizing the implementation of these approaches across diverse clinical disciplines to enhance teaching quality and student learning outcomes remains a critical challenge in medical education.

This study aims to evaluate the effectiveness of combining Case-Based Learning (CBL), Problem-Based Learning (PBL), Standardized Patients (SP), and Evidence-Based Medicine (EBM) in clinical teaching. By analyzing the specific contributions of these pedagogies in enhancing students' clinical skills, critical thinking, and communication abilities, the study seeks to provide evidence to support the reform and optimization of medical education methodologies.

2. Methods

2.1 Study design

This study employed a prospective controlled design to evaluate the effectiveness of combining Case-Based Learning (CBL), Problem-Based Learning (PBL), Standardized Patient (SP), and Evidence-Based Medicine (EBM) teaching methodologies in clinical education. Participants were randomly assigned to one of two groups: an experimental group that received instruction through a combination of teaching methods (CBL, PBL, SP, and EBM) or a control group that followed a traditional didactic teaching approach. The study compared the two groups across multiple outcomes, including critical thinking skills, clinical procedural skills, evidence-based medical reasoning, learning motivation, and teaching satisfaction.

2.2 Study Objects

A total of 100 clinical medicine students from Guizhou Medical University, who were undertaking internships in obstetrics and gynecology in 2024, were recruited as study participants. These students were randomly assigned to either an experimental group or a control group, with 50 students in each group. All

participants had comparable academic backgrounds and clinical training experiences, ensuring baseline equivalence between the groups. A simple randomization method was employed, whereby students were assigned a number from 1 to N; odd numbers were allocated to the experimental group, and even numbers to the control group. Each group was supervised by a dedicated teaching team comprising one faculty member and three full-time professional assistants from the Department of Geriatrics or the Department of Obstetrics and Gynecology.

2.3 Teaching methods

Students in the experimental group received training through a combination of CBL (Case-Based Learning), PBL (Problem-Based Learning), SP (Standardized Patients), and EBM (Evidence-Based Medicine) teaching methods.

The specific components were as follows:

CBL: Instructors prepared typical clinical cases for students to analyze. Students discussed diagnostic and treatment options, incorporating the latest evidence from evidence-based medicine.

PBL: Clinical problems were integrated into each teaching unit. Students addressed these problems through independent literature review, group discussions, and exploratory learning.

SP: Simulated clinical scenarios were created using standardized patients. Students practiced history-taking, physical examinations, and communication skills through role-playing under controlled and realistic conditions.

EBM: Students were guided to search for relevant evidence using evidence-based medicine resources. They applied this evidence in clinical case analysis, gaining proficiency in using high-quality medical evidence for clinical decision-making.

Control Group: Students in the control group were taught using traditional didactic teaching methods (Lecture-Based Learning, LBL). This approach involved theoretical instruction and limited clinical case discussions led by the instructor. Practical training followed the standard clerkship model.

2.4 Evaluation method

Critical Thinking Skills: The assessment of critical thinking skills was conducted using the Critical Thinking Skills Inventory (CTSI), which evaluates four key dimensions: analytical skills, systematization skills, confidence in critical thinking, open-mindedness. Both groups of students underwent testing before and after the instructional intervention to measure changes in their critical thinking abilities.

Clinical Operational Skills: Clinical operational skills were evaluated using the Mini Clinical Evaluation Exercise (Mini-CEX), which encompasses key components such as history taking, physical examination, diagnostic and therapeutic decision-making, communication skills, and overall performance. Assessments were conducted both before and after the instructional intervention to measure

skill development.

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Autonomous learning motivation and teaching satisfaction were evaluated using specifically designed questionnaires. These tools assessed students' motivation to learn, their satisfaction with the instructor, and their perception of the teaching methodology. The questionnaires covered various aspects, including learning interest, classroom engagement, and teacher-student interaction.

2.5 Statistical methods

Data analysis was performed using SPSS 26.0 software (IBM Corp., Armonk, NY). An independent samples t-test was employed to compare differences between the experimental and control groups in critical thinking, clinical skills, and evidence-based medicine competencies. For quantitative data related to teaching satisfaction and autonomous learning motivation, the chi-square test was used. A p-value of <0.05 was considered statistically significant.

3. Results

3.1. Basic characteristics and information

Table 1 presents the baseline characteristics of participants in the experimental and control groups. No significant differences were identified between the two groups in terms of age, gender distribution, baseline critical thinking scores, baseline clinical skills scores, and baseline evidence-based medicine (EBM) competency scores ($p > 0.05$).

The mean age in the experimental group was 22.5 ± 1.2 years, compared to 22.3 ± 1.4 years in the control group, with no statistically significant difference ($p > 0.05$). The gender ratio was 24:26 (male) in the experimental group and 25:25 in the control group, with no significant difference ($p > 0.05$).

Baseline critical thinking scores were 235.12 ± 15.10 for the experimental group and 234.45 ± 14.85 for the control group, with no significant difference ($p > 0.05$). Baseline clinical skills scores were 6.5 ± 1.1 in the experimental group and 6.4 ± 1.0 in the control group, also showing no significant difference ($p > 0.05$). Similarly, baseline EBM competency scores were 22.5 ± 2.3 for the experimental group and 22.4 ± 2.5 for the control group, with no statistically significant difference ($p > 0.05$).

These findings confirm that the baseline characteristics of the two groups were comparable, providing a reliable foundation for subsequent comparisons of the intervention outcomes.

Table 1. Baseline Characteristics of Experimental and Control Groups

Variable	Experimental Group (n=50)	Control Group (n=50)	p Value
Age (years, mean $\pm$ SD)	22.5 $\pm$ 1.2	22.3 $\pm$ 1.4	>0.05
Gender (Male/Female)	24 / 26	25 / 25	>0.05
Baseline Critical Thinking Score	235.12 $\pm$ 15.10	234.45 $\pm$ 14.85	>0.05
Clinical Skills Score	6.5 $\pm$ 1.1	6.4 $\pm$ 1.0	>0.05
EBM Competency Score	22.5 $\pm$ 2.3	22.4 $\pm$ 2.5	>0.05

3.2 Comparison of Final Critical Thinking Skills of Two Groups of Interns

There was a significant difference between the total score of critical thinking skills and the scores of each dimension in the posttest between the experimental and control groups, with the experimental group being significantly higher than the control group ($p < 0.01$). Total score of critical thinking skills: the mean value of the experimental group in the post-test was 280.34 ± 15.23 and that of the control group was 234.12 ± 14.32 , which was significantly higher in the experimental group than in the control group ($p < 0.01$). The score of the experimental group of analytical ability was 45.12 ± 4.32 and the control group was 37.21 ± 4.10 , and the difference was statistically significant ($P < 0.01$). The score of the experimental group of systematic ability was 44.32 ± 3.78 and the control group was 35.12 ± 4.54 , the difference was significant ($p < 0.01$). Critical thinking confidence experimental group scored 42.78 ± 4.01 and the control group was 36.23 ± 4.34 , the difference was statistically significant ($p < 0.01$). Open-mindedness experimental group scored 43.22 ± 3.98 and control group was 35.67 ± 4.10 , which is significantly higher than the control group ($p < 0.01$). The results are presented in **Table 2**. These results, detailed in **Table 2**, highlight the superior performance of the experimental group across all dimensions of critical thinking skills.

Table 2. Scores on the Critical Thinking Skills Test after instruction for both groups of students

group	Total score	Critical Thinking Skills Dimension			
		analytical ability	Systematic capacity	Critical Thinking Self Confidence	open-mindedness
Control group	134.12 $\pm$ 14.32	37.21 $\pm$ 4.10	35.12 $\pm$ 4.54	36.23 $\pm$ 4.34	35.67 $\pm$ 4.10
Experimental group	180.34 $\pm$ 15.23	45.12 $\pm$ 4.32	44.32 $\pm$ 3.78	42.78 $\pm$ 4.01	43.22 $\pm$ 3.98
p Value	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01

3.3 Comparison of clinical skills performance between students in the experimental and control groups in the Mini-CEX assessment

The results of the Mini-CEX assessment demonstrated that the experimental group performed significantly better than the control group across all evaluation dimensions ($p < 0.01$). Overall Performance: The experimental group achieved

a mean score of 8.34 ± 0.88 , which was significantly higher than the control group's score of 6.78 ± 1.05 ($p < 0.01$). History Taking: The mean score for history taking was 8.34 ± 0.76 in the experimental group, compared to 6.78 ± 1.01 in the control group, indicating a statistically significant difference ($p < 0.01$). Physical Examination: Students in the experimental group scored 8.12 ± 0.89 , while the control group scored 6.45 ± 1.09 ($p < 0.01$). Treatment Decision-Making: The mean score for treatment decision-making was 8.21 ± 0.82 in the experimental group, significantly higher than the control group's score of 6.95 ± 1.10 ($p < 0.01$). Communication Skills: The experimental group scored 8.45 ± 0.90 , compared to the control group's score of 6.78 ± 1.05 , reflecting a statistically significant improvement ($p < 0.01$). The statistical significance ($p < 0.01$) across all evaluation indicators highlights the substantial difference in clinical skill performance between the two groups. These findings confirm that the combined teaching methods applied in the experimental group were more effective in improving students' clinical competence as assessed by the Mini-CEX. The detailed results are summarized in **Table 3**.

Table 3. Assessment results of the two groups of students in Mini-CEX

group	Total score	Clinical Practice Skills Score			
		history taking	clinical examination	diagnostic and treatment decisions	communication skill
Control group	6.78 ± 1.05	6.78 ± 1.01	6.45 ± 1.09	6.95 ± 1.10	6.78 ± 1.05
Experimental group	8.34 ± 0.88	8.34 ± 0.76	8.12 ± 0.89	8.21 ± 0.82	8.45 ± 0.90
p Value	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01

3.4 Comparative analysis of students' competence in evidence-based medicine in the experimental and control groups

In the evidence-based medicine (EBM) competence assessment, the experimental group demonstrated significantly better performance compared to the control group across all evaluated indicators ($p < 0.01$). Overall Performance: The experimental group achieved a mean score of 26.88 ± 2.30 , significantly higher than the control group's score of 22.88 ± 2.45 ($p < 0.01$). Evidence Searching: The experimental group scored 9.12 ± 0.85 , compared to 7.87 ± 0.94 in the control group ($p < 0.01$). Quality Assessment of Evidence: The mean score for quality assessment was 8.89 ± 0.88 in the experimental group, significantly surpassing the control group's score of 7.56 ± 0.95 ($p < 0.01$). Evidence Application: Students in the experimental group scored 8.87 ± 0.91 , while the control group scored 7.45 ± 1.04 ($p < 0.01$). The statistically significant differences ($p < 0.01$) in all dimensions indicate that the experimental group exhibited superior competence in EBM. These results highlight the effectiveness of the combined teaching methods in enhancing students' EBM-related skills. The detailed findings are presented in **Table 4**.

Table 4. Results of the assessment of students' competence in evidence-based medicine in both groups

group	Total score	Evidence-based medicine competency dimensions		
		Evidence Search	Assessing the quality of evidence	Application of evidence
Control group	22.88 ± 2.45	7.87 ± 0.94	7.56 ± 0.95	7.45 ± 1.04
Experimental group	26.88 ± 2.30	9.12 ± 0.85	8.89 ± 0.88	8.87 ± 0.91
p Value	< 0.01	< 0.01	< 0.01	< 0.01

3.5 Results of Comparison of Teaching Satisfaction and Learning Motivation of the Two Groups of Students

In the assessment of teaching satisfaction and learning motivation, students in the experimental group scored significantly higher than those in the control group across all evaluated dimensions, with all differences reaching statistical significance ($p < 0.01$).

Specifically, satisfaction with teaching methods was rated at 95.23% in the experimental group, markedly higher than the control group's 75.34%. Similarly, learning motivation scores were 94.12% in the experimental group compared to 70.89% in the control group. Teacher-student interaction satisfaction also showed a significant difference, with the experimental group scoring 92.45% compared to 72.13% in the control group. These results demonstrate that the experimental group achieved significantly greater teaching satisfaction and motivation, underscoring the effectiveness of the combined teaching methods in enhancing these aspects. The detailed findings are summarized in **Table 5**.

Table 5. Results of Students' Teaching Satisfaction in Both Groups

group	Teaching satisfaction and motivation		
	Satisfaction with teaching methods	motivation	Teacher-Student Interaction Satisfaction
Control group	75.34%	70.89%	72.13%
Experimental group	95.23%	94.12%	92.45%
p Value	< 0.01	< 0.01	< 0.01

4 Discussion

This study compared the effects of combined CBL, PBL, SP, and EBM teaching methods with traditional lecture-based teaching in clinical education. The results demonstrated that the combined teaching approach significantly improved critical thinking, clinical skills, evidence-based medicine (EBM) abilities, teaching satisfaction, and learning engagement. These findings indicate that integrating multiple teaching methods can address the shortcomings of traditional approaches, thereby enhancing students' overall competencies more effectively.

The combination of CBL (Case-Based Learning) and PBL (Problem-Based Learning) guides students in analyzing and solving complex clinical problems, fostering critical thinking skills. CBL provides opportunities to apply knowledge in specific clinical contexts through real or simulated cases, while PBL further

stimulates autonomous exploration and reasoning by employing problem-driven strategies. This combination not only enhances students' depth of thinking but also improves their ability to systematically solve clinical problems. Compared to traditional lecture-based teaching, CBL and PBL better encourage self-directed learning and in-depth reflection, explaining the observed significant improvement in critical thinking among students in the experimental group.

The introduction of SP (Standardized Patients) offers students a near-real clinical environment for repeated practice, circumventing the limitations of real patient settings, such as patient discomfort or external factors. Interaction with SPs allows students to enhance their procedural skills, develop better doctor-patient communication, and refine clinical decision-making. Additionally, the integration of real-time feedback mechanisms, such as Mini-CEX, enables students to promptly identify and address deficiencies, a distinct advantage over traditional teaching methods. Consequently, SP-based teaching demonstrates significant effectiveness in improving students' procedural confidence and competency.

EBM teaching trains students to search for and apply the best available evidence, fostering scientific and rigorous clinical decision-making. The integration of CBL and PBL not only allows students to analyze real cases but also teaches them how to utilize the latest research and evidence to support clinical decisions. Therefore, the combined teaching approach plays a crucial role in developing evidence-based thinking and clinical judgment.

Despite the significant advantages demonstrated by the combined teaching approach, this study has some limitations. First, the small sample size may restrict the generalizability of the findings; future research should include larger sample sizes to improve representativeness. Second, the relatively short teaching duration limits the assessment of long-term outcomes. Future studies could incorporate long-term follow-up to evaluate the sustained impact of this approach in clinical practice. Additionally, as clinical teaching needs vary across specialties, the effectiveness of combined teaching methods may differ in various disciplines. Further research is needed to explore its broad applicability across multiple specialties.

In conclusion, this study demonstrates that the combined use of CBL, PBL, SP, and EBM teaching methods effectively overcomes the limitations of traditional approaches, particularly in fostering critical thinking, clinical skills, and evidence-based thinking. These findings provide strong support for medical education reform and advocate for the broader adoption of innovative teaching methods in clinical education to enhance medical students' comprehensive abilities and better prepare them to address complex clinical challenges in their future practice.