

Application Efficacy and Practical Exploration of CBL Combined with Flipped Classroom Model in Internal Medicine Teaching

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Abstract: Internal Medicine is a core course bridging basic medical sciences and clinical practice. The traditional lecturebased teaching model suffers from notable shortcomings, including a disconnect between theory and clinical application, insufficient active thinking among students, and weak training in clinical reasoning. To better align with competencyoriented medical talent development goals, this study explores a flipped classroom practice model based on casebased learning (CBL). Through a closedloop design of “preclass case preview → inclass multidimensional interaction → postclass extended improvement,” combined with typical cases from multiple systems in Internal Medicine, the teaching practice was implemented. Practice has shown that this model effectively stimulates students’ learning interest, strengthens clinical reasoning and selfdirected learning abilities, facilitates the translation of theoretical knowledge into clinical practice, and improves teaching satisfaction. It provides a replicable practical approach for the reform of Internal Medicine practical teaching and offers a useful reference for medical educators.

Keywords: Internal Medicine; Flipped classroom; Case-based learning; Practical teaching; Medical teaching reform

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1. Introduction

Internal Medicine serves as a bridging course that connects medical fundamentals with clinical practice. Its knowledge system is complex and highly practiceoriented, playing an irreplaceable role in cultivating medical students’ clinical reasoning and job competency ^[1]. Traditional Internal Medicine classrooms are largely dominated by teachercentered lectures, focusing on knowledge delivery, with cases used primarily for illustration. Students passively receive information without adequate opportunities for independent case analysis. This not only fails to stimulate learning initiative but also leads to a disconnect where students “understand the theory but cannot apply it,” making it difficult to meet the requirements of highquality

clinical talent training in modern medical education ^[2].

The flipped classroom, as a studentcentered teaching model, restructures the learning sequence inside and outside the classroom and adjusts the teaching process. Classroom sessions are designed primarily for discussion, critical thinking, and scenario simulations, enhancing student interaction and participation. By selecting authentic clinical cases as learning vehicles that align with Internal Medicine theories, it forms an integrated teaching model ^[3], offering an effective approach to addressing the pain points of traditional teaching ^[4]. This study, integrating the characteristics of Internal Medicine teaching and incorporating casebased learning (CBL), has constructed and implemented a flipped classroom model for Internal Medicine. The practical experience and reflections are presented below.

2. Background and core design of the flipped classroom practice

2.1. Practice background

The limitations of traditional Internal Medicine teaching are increasingly evident: first, the teaching focus leans heavily toward theoretical indoctrination, with clinical cases used mainly as supplementary examples, leaving students with insufficient training in comprehensive historytaking, differential diagnosis, and treatment decisionmaking; second, classroom time is dominated by teacher lectures, with limited opportunities for student participation and interaction; most students are accustomed to listening and notetaking, and clinical reasoning training becomes merely superficial; third, the learning process lacks personalized guidance, making it difficult to accommodate the varying needs of students with different backgrounds. A review of relevant teaching reform literature shows that a flipped classroom without clinical cases as a focal point may easily devolve into online selfstudy plus simple classroom Q&A, failing to achieve clinical reasoning training goals; conversely, CBL alone is constrained by class time, and insufficient preclass preparation limits the depth of inclass discussion ^[4]. The flipped classroom, through its reconstruction of “preclass independent learning + inclass deep interaction,” can effectively address these shortcomings. Meanwhile, casebased learning, using clinical cases as the core vehicle, aligns well with the discipline’s characteristic of integrating theory and practice ^[5]. Combining the two to construct a teaching pathway of “preclass independent learning for knowledge acquisition, and inclass casebased deep discussion” is expected to overcome the above limitations and meet competencyoriented medical education goals ^[6].

2.2. Core design concept

Guided by the core principles of “cases as the vehicle, flipped classroom as the mainline, and competency as the goal,” a threestage closedloop teaching model of “preclass case preview → inclass multidimensional interaction → postclass extended improvement” has been developed. The core concepts include: shifting the teaching center from “teachercentered” to “studentcentered,” emphasizing students’ active participation; shifting the teaching vehicle from “pure theory” to “clinical cases,” integrating theoretical knowledge into authentic clinical scenarios; shifting the teaching process from “classroom lectures + homework” to “preclass preview + inclass interaction + postclass extension,” reinforcing knowledge digestion and application; and shifting the teaching objective from “knowledge mastery” to “competency enhancement,” focusing on clinical reasoning, selfdirected learning, and teamwork skills ^[7].

3. Practical design and implementation of the Internal Medicine flipped classroom

3.1. Clinical case selection and standardized design

3.1.1. Construction of a standardized case bank

Case selection strictly followed five principles: “classic, typical, practical, graduated, and practically adaptable” [8]. The cases covered core Internal Medicine systems including respiratory, circulatory, digestive, renal, and emergency medicine, with 18 common and frequently encountered diseases such as communityacquired pneumonia, acute myocardial infarction, and acute pancreatitis. The specific operational procedures were as follows:

Case screening process: A case selection panel composed of 3 senior physicians and clinical teaching faculty first screened 30 candidate cases from authentic clinical records, excluding rare diseases and cases with incomplete diagnostic and treatment workflows, retaining 22 cases. These were then crossreferenced with the core knowledge points of the Internal Medicine syllabus, ultimately determining 18 core cases, ensuring that each core system covered at least 2–3 representative diseases.

Standardized module design: All cases adopted an “8+2” module structure. The 8 basic modules included: case basic information, history collection (including chief complaint, history of present illness, past history, personal history, family history), physical examination (general examination + focused specialty examination), ancillary tests (laboratory tests + imaging + special tests), preliminary diagnosis, differential diagnosis, treatment plan, and prognosis analysis. Additionally, two teachingspecific modules were added: (1) thinking expansion points (reserving 1–2 key information gaps or diagnostic points of divergence), for example, hiding “lipid profile results” in a coronary artery disease case, or setting up “difficulties in distinguishing bacterial versus viral pneumonia” in a pneumonia case; (2) teaching adaptation points (annotating the case’s corresponding teaching objectives, core knowledge points, and common pitfalls), for example, marking “reperfusion therapy time window” and “ECG feature recognition” as core teaching points in an acute myocardial infarction case.

Graded classification criteria: Cases were classified into three difficulty levels, with clearly defined applicable scenarios and competency requirements: (1) Basic level (10 cases): suitable for junior students or new teaching chapters. Cases feature typical histories and straightforward differential diagnoses, such as “communityacquired pneumonia without underlying diseases” and “typical acute glomerulonephritis.” The focus is on combining theory with clinical fundamentals, requiring students to master the typical clinical manifestations, diagnostic criteria, and basic treatment regimens. (2) Advanced level (5 cases): suitable for intermediate students or review chapters. Cases feature complex histories with complications or comorbidities, such as “chronic heart failure with hypertension and diabetes” and “acute pancreatitis induced by cholelithiasis.” The focus is on diagnosis and treatment planning, requiring students to perform differential diagnosis and formulate individualized treatment plans. (3) Comprehensive level (3 cases): suitable for senior students or comprehensive training. Cases feature crosssystem diseases or critical conditions, such as “acute myocardial infarction complicated by cardiogenic shock” and “multiple organ dysfunction syndrome.” The focus is on enhancing crosssystem diagnostic and treatment abilities, requiring students to integrate multidisciplinary knowledge and manage acute and critical conditions.

3.1.2. Supporting preview resources and online platform configuration

To ensure effective preclass independent learning, a diversified preview package was developed, with each case accompanied by a tailored set of resources, including:

Microlecture introduction (8–10 minutes): In the form of microvideos or presentations, structured as “clinical scenario introduction + knowledge point breakdown + summary review.” For example, the microlecture on “communityacquired pneumonia” begins with a case introduction of “a 58yearold farmer with fever and cough for 3 days,” followed by a breakdown of core knowledge points including “etiological classification, typical symptoms and signs, interpretation of ancillary tests, diagnostic criteria,” and concludes with a summary of the “core diagnostic and treatment logic for pneumonia.” This facilitates learning during fragmented time.

Tiered question chains: Designed at three levels—“basic, advanced, and exploratory”—with 2–3 questions per level, including objective, subjective, and inquirybased types: (1) Basic questions (focusing on knowledge recall), such as “What are the typical clinical manifestations of pneumonia?” “What are the characteristic ECG findings of acute myocardial infarction?”; (2) Advanced questions (focusing on knowledge application), such as “What are the differences in ancillary test characteristics among pneumonias caused by different pathogens?” “What are the treatment principles for hypertension with heart failure?”; (3) Exploratory questions (focusing on critical thinking), such as “Why are the clinical manifestations of pneumonia in the elderly often atypical?” “Why is fasting and gastrointestinal decompression necessary for patients with acute pancreatitis?”

Recommended reference materials: 3–5 core references were selected for each case, including corresponding textbook chapter summaries (distilling core knowledge points to avoid aimless reading), excerpts from the latest clinical guidelines, and 1–2 short articles from core journals published within the last 3 years focusing on new advances in disease diagnosis and treatment, providing precise support for indepth student learning.

Online learning platform functions: Rain Classroom was selected to build the learning platform, with modules for “preview slides, preview checkin, online discussion, and preclass quiz”: (1) Slides support variablespeed playback, bookmarking, and offline viewing; (2) Checkin criteria require 100% completion of “microlecture viewing” and “preclass quiz” to encourage selfpacing; (3) The discussion forum employs a mechanism of “random teacherstudent questions, responses, and compilation of common issues,” with common questions aggregated.

Each teaching case was accompanied by a dedicated preview resource package: An 8–10 minute microlecture introduction, a tiered threelevel question chain, and a curated reference compilation. Microlectures followed the structure of case introduction, knowledge point breakdown, and key takeaways, adapted to fragmented selflearning. Question chains were classified into three levels: basic recall, knowledge application, and exploratory inquiry. Reference materials included key textbook chapters, excerpts from recent clinical guidelines, and short articles from core journals published within the last 3 years, helping students avoid aimless, extensive reading^[9].

Online, the Rain Classroom platform was used to assign preview tasks, push microlectures, conduct preclass quizzes, and facilitate discussion board interactions. Instructors could track preview completion and quiz performance on the back end and provide targeted reminders to students lagging behind in preview progress^[6,7].

3.2. Implementation of the threestage closedloop teaching process

3.2.1. Preclass stage: Casedriven independent preview

One week before class, the preview package and task sheets are distributed to students via the online

platform, with clear learning objectives and task requirements: (1) Students with weaker foundational knowledge are required to complete microlecture viewing and basic level questions to ensure mastery of core knowledge points; (1) Students with stronger foundations are additionally required to complete advanced and exploratory level questions, and to attempt to articulate the diagnostic reasoning process for the case while raising 1–2 targeted questions. During students' independent learning, instructors continuously monitor progress through the platform, provide timely reminders to those who fall short of requirements, and offer individualized tutoring—for example, by pushing supplementary resources such as “knowledge mind maps” and “common error analysis” to students with weaker foundations ^[10,11].

3.2.2. Inclass stage: Multidimensional interactive indepth exploration

Each class session lasts 90 minutes and revolves around the case with multiple forms of interactive teaching, emphasizing thinking training and practical simulation. The specific process includes: (1) Small group discussion (30 min): Students are divided into groups of 6–7, with a group leader appointed. Each group works on three tasks: formulating a preliminary diagnosis with supporting evidence, identifying key points for differential diagnosis and exclusion, and developing a treatment plan. Instructors circulate and observe group discussions; when deviations in reasoning are observed, they guide through questioning rather than providing direct answers. Groups that fall behind in discussion are given prompt cards to support their thinking ^[12]. (2) Scenario based roleplay simulation (20 min): Selected groups participate in scenario simulations covering three types: doctor-patient communication and informed consent, emergency management, and case presentation for consultation, respectively, training abilities in history communication, emergency procedures, and logical case presentation ^[12,13]. (3) Instructor led targeted elaboration and debriefing (30 min): Based on common issues collected before class and misconceptions revealed during group discussions, the instructor systematically presents the complete clinical reasoning chain. Each group's performance is commented on, with strengths acknowledged and reasoning gaps pointed out. A simple award mechanism is used to stimulate classroom participation ^[12].

3.2.3. Postclass stage: Tiered progressive extension and enhancement

After class, tiered extension tasks are assigned according to students' ability levels to achieve knowledge consolidation and skill transfer:

Mandatory basic tasks and optional advanced tasks are set. The mandatory task requires students to complete a full written case summary, including diagnosis, differential diagnosis, and treatment plan, following the standards of medical record writing; instructors review each submission and annotate any issues ^[1]. For optional advanced tasks, students choose one of two options: write a brief literature review on a controversial aspect of the disease's diagnosis and treatment, or adapt the original case by adding comorbidities to create a new case with accompanying discussion questions. The online platform remains available for students to continue asking questions and engaging in discussions, with ongoing push of guidelines, case videos, and other extended resources, forming a full cycle teaching support system spanning “preclass–inclass–postclass” ^[7].

3.3. Teaching support measures

3.3.1. Division and collaboration of the teaching team

A teaching team comprising “clinicians + course instructors + teaching assistants” has been established, with clear division of responsibilities: clinicians are responsible for case selection, core knowledge point

organization, and inclass clinical reasoning guidance; course instructors are responsible for teaching process design, question chain development, and assessment; teaching assistants are responsible for online platform maintenance, preview progress tracking, and preliminary organization and grading of assignments. The team adheres to a collective lessonpreparation system and conducts regular training sessions on flipped classroom teaching methods to ensure consistent teaching standards ^[12]. Training content includes “case design techniques,” “classroom facilitation methods,” and “teaching resource production.” Through collective lesson preparation, teaching observation, and experience sharing, teaching standards and processes are unified; case design, question chain gradation, and classroom time allocation for the upcoming session are discussed and optimized to ensure teaching quality stability ^[14].

3.3.2. Student orientation and training

Prior to implementing the flipped classroom, a dedicated orientation session is conducted to explain the complete teaching process, independent learning methods, smallgroup discussion rules, and evaluation methods. (1) Teaching process breakdown: A flowchart is used to visually demonstrate the operational steps and timelines for each stage—“preclass preview–inclass interaction–postclass extension.” (w2) Learning method guidance: Instruction is provided on “independent learning techniques” (e.g., how to effectively use microlectures, how to search literature), “smallgroup discussion rules” (e.g., how to actively participate, how to listen to others), and “Rain Classroom usage” (e.g., resource access, Q&A, assignment submission). (3) Evaluation methods: The assessment scheme is clearly defined as “formative assessment 60% + summative assessment 40%.” Formative assessment includes preview completion, class participation, and postclass assignment quality, helping students clearly understand the evaluation expectations ^[11].

3.3.3. Teaching resource updating and optimization

A dynamic teaching resource iteration mechanism has been established, including: (1) Regular updates: Every six months, the case bank, microlecture videos, and reference materials are updated in light of the latest clinical guidelines and research advances—for example, updating treatment protocols and supplementing newly recommended drugs and therapeutic strategies according to updated guidelines. (2) Feedbackdriven optimization: After each class, “student feedback questionnaires” are used to collect student opinions on preview resources, classroom interaction, and postclass tasks. (3) Resource sharing: Excellent student work—including case writeups, literature reviews, and case adaptations—is incorporated into the teaching resource bank as demonstration examples for future teaching ^[7].

4. Teaching practice outcomes and reflections

After multiple rounds of course practice, student participation in class has markedly improved compared with traditional lecturebased classes. Most students actively engage in case analysis and discussion, gradually establishing a clinical thinking habit of “information gathering → comprehensive assessment → differential diagnosis → formulating a plan.” From the feedback on postclass assignments, 85% of students were able to independently complete literature searches and comprehensive case analyses, a significant improvement over the previous traditional teaching phase ^[2].

An anonymous questionnaire survey and teacherstudent discussions were conducted at the end of the course. Student feedback showed that 92% considered this model effective in stimulating their own

learning initiative, 88% found that inclass interaction helped deepen their understanding of internal medicine diseases, and 83% acknowledged the value of tiered postclass extension tasks in developing comprehensive competencies^[3]. From the instructors' perspective, students actively posed thoughtprovoking questions, no longer confined to textbook knowledge, and more knowledge gaps were exposed during class, facilitating targeted teaching and achieving mutual learning between teachers and students^[12].

A comparison of teaching outcomes before and after implementation of this teaching model in the same class type across 2024 and 2025 is shown in **Table 1**. Student independent learning completion rates, classroom participation, and teaching satisfaction all improved significantly, and scores in case analysis and final examinations both increased.

Table 1. Comparison of internal medicine teaching outcomes before and after implementation of the CBLbased flipped classroom

Indicator	Traditional lecture-based teaching (<i>n</i> = 50)	CBL combined with flipped classroom (<i>n</i> = 50)	Statistic	<i>P</i> value
Autonomous learning task completion rate of trainees (%)	62.00	85.00	$\chi^2 = 7.48$	<0.01
Proportion of trainees actively participating in class discussions (%)	41.00	82.00	$\chi^2 = 16.98$	<0.001
Teaching satisfaction rate of trainees (%)	71.00	92.00	$\chi^2 = 6.78$	<0.01
Excellent/good rate of clinical competence evaluation by instructors (%)	72.00	87.00	$\chi^2 = 7.89$	<0.01
Proportion able to independently complete comprehensive case analysis assignments (%)	45.00	85.00	$\chi^2 = 17.83$	<0.001
Mean score of case analysis examination (points)	78.24 ± 7.38	83.69 ± 6.15	<i>t</i> = 4.01	<0.001
Mean score of final theoretical examination (points)	81.36 ± 6.21	84.52 ± 5.47	<i>t</i> = 2.7	<0.01

Note: Measurement data are expressed as mean ± standard deviation (SD), and between-group comparisons were performed using independentsample *t*tests. Count data are presented as *n* (%), and between-group comparisons were performed using the chisquare (χ^2) test. A *P*value < 0.05 was considered statistically significant.

This teaching model breaks through the limitations of traditional internal medicine instruction, establishing a standardized teaching process, case bank, and resource system. Through the deep integration of casebased learning and the flipped classroom, it achieves an effective connection between theoretical knowledge and clinical practice, shortens the adaptation period from classroom to clinical setting, and better aligns with the “postoriented, competencycentered” cultivation needs of modern medical education, providing a practical paradigm for the reform of internal medicine teaching.

5. Practical challenges encountered and improvement strategies

5.1. Current major issues

(1) Varied quality of student previews. Some students, constrained by academic pressure and a lack of selfdirected learning habits, have limited completion quality of microlectures and preclass exercises. Approximately 15% of students fail to meet basic preview requirements, and 10% complete the question chains perfunctorily, which directly constrains the depth of inclass discussions. A small number of students

merely complete the minimum tasks mechanically without engaging in deep thinking ^[11]. (2) Group discussions tend to become superficial. In some groups, discussions rely heavily on a few students, while quieter students have fewer participation opportunities. During roleplay sessions, some students lack adequate communication training, and the gap between simulation and real clinical scenarios remains considerable ^[12]. (3) Increased teaching burden on instructors. Compared with traditional teaching, tasks such as case refinement, microlecture production, pre and postclass Q&A, and assignment grading have increased faculty workload by approximately 30–40% ^[12], making it challenging for individual instructors to sustain this teaching model over the long term.

5.2. Improvement directions

First, strengthen the quality control of the preview phase. Preclass quiz scores should be included in the formative assessment with an appropriate weight; students who fail need to recomplete the preview tasks. Simplified preview materials can be provided for those with weaker foundations. Peer learning pairs can be formed, pairing stronger students with weaker ones to support joint preclass learning ^[11]. Second, optimize the operation of inclass groups. Rotating roles such as recorder, spokesperson, and questioner should be assigned within groups to ensure everyone participates. Preclass demonstration videos on communication scenarios can be added to provide reference materials for roleplay ^[14]. During classroom walkthroughs, instructors should pay special attention to silent students and proactively ask questions to guide their expression ^[12]. Third, reduce faculty workload through teambased division of labor. Teaching tasks can be distributed according to disease systems, with collective development of cases and question chains to enable resource sharing. Outstanding students can be selected as teaching assistants to handle preview statistics, initial assignment screening, and basic online Q&A, while instructors focus on instructional design, classroom guidance, and final assignment review. AI tools may also be appropriately utilized for initial material processing to reduce repetitive work ^[15].

5.2.1. Enhancing preview quality control

First, tightly link preview performance with formative grades by adding preclass quizzes (accounting for 40% of the preview score); students scoring below 60 must redo the preview. Second, implement stratified preview design by providing “knowledge point checklists + simplified question chains + keypoint annotations in microlectures” for weaker students to lower the preview difficulty. Third, establish peer learning groups pairing stronger and weaker students to encourage mutual learning and create a collaborative learning atmosphere, with regular guidance and assessment provided by the instructor ^[11].

5.2.2. Optimizing inclass interaction organization

First, refine group role assignments with rotating positions such as recorder, spokesperson, and questioner to ensure every student participates. Preclass communication scenario demonstration videos can be added to provide reference materials for roleplay ^[14]. Second, improve classroom facilitation techniques; instructors should pay special attention to silent students during walkthroughs and proactively ask questions to guide their expression, deepening group discussions ^[12]. Third, add roleplay training sessions at the early stage of flipped classroom implementation, offering targeted training on “physicianpatient communication skills” and “emergency procedure standards,” with standardized script templates and demonstration videos to enhance students’ practical performance ^[14].

5.2.3. Reducing faculty workload

First, establish a collaborative teaching team with task division based on disease systems, enabling collective development of cases and question chains for resource reuse and avoiding redundant work. Second, implement a teaching assistant system by selecting top students or junior physicians to handle preview statistics, initial assignment screening, and basic online Q&A, while the lead instructor focuses on instructional design, classroom guidance, and final assignment review. Third, moderately utilize AI tools to assist in preliminary material processing and reduce repetitive work^[12].

6. Conclusion

The flipped classroom practical teaching model in Internal Medicine, through the innovative approach of “casedriven + flipped interaction,” effectively addresses the pain points of traditional teaching, achieving a shift in teaching focus and an upgrade in teaching objectives. Practice has demonstrated that this model can stimulate students’ learning interest, strengthen clinical reasoning, selfdirected learning, and teamwork abilities, promote the deep integration of theoretical knowledge with clinical practice, and enhance teaching quality and satisfaction. Although some challenges remain in the implementation process, continuous refinement of instructional design and improvement of support mechanisms can further enhance teaching effectiveness. The reform of internal medicine teaching is an ongoing process of iterative improvement. In the future, we will continue to ground our efforts in postoriented training needs, continuously optimize the case bank, refine each phase of quality control, and further leverage the advantages of the flipped classroom combined with CBL to accumulate practical teaching experience for cultivating medical professionals with solid clinical competencies^[8,13].

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