

Evaluation of Medical Students' Experience with AI-Enhanced Clinical Skills Teaching and Curriculum Optimization Pathways

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ABSTRACT:

Objective: To explore medical students' perceptions, attitudes, current status, and development prospects regarding artificial intelligence (AI)-enhanced clinical skills teaching, and to provide empirical evidence for optimizing the application of AI in clinical skills education.

Methods: A questionnaire survey was conducted among students at a medical university. The questionnaire covered four modules: basic information, AI literacy cognition scale, current status of clinical skills teaching, and prospects of AI-empowered medical education. A five-point Likert scale was used, with statistical charts and analyses.

Results: Sophomores and juniors exhibited higher AI literacy than freshmen, but all showed a pattern of "positive attitude yet insufficient mastery" (application attitude $\bar{x} > 4.0$, technical mastery $\bar{x} < 3.7$). Although AI teaching tools have achieved some penetration, they are mainly used for shallow applications such as intelligent Q&A, while deep applications like personalized learning recommendations remain underutilized and are difficult to integrate into practical courses. For optimizing basic clinical skills courses, students preferred innovative pedagogies such as PBL and CBL, and advocated for more hands-on opportunities (e.g., community-based practice).

Conclusion: Currently, AI in medical higher education faces a triple dilemma: "cognition-ability disconnect," "shallow application," and "theory-practice separation." Future AI-empowered clinical skills teaching should move toward personalized development, enhanced classroom flexibility, increased authenticity of clinical skills training, and integration with community service practice, thereby providing a theoretical basis for AI-enhanced medical education.

KEYWORDS: Artificial intelligence; Basic clinical skills; Medical education; Practical teaching

I. INTRODUCTION

With the deepening of the "Healthy China 2030" strategy, cultivating high-level medical talents with post competency has become a core goal of medical education. To keep pace with the trends of the era, there is an urgent need to cultivate interdisciplinary medical talents who are adaptable to smart healthcare and possess high artificial intelligence (AI) literacy. Currently, AI technology has been widely applied in medical imaging recognition, auxiliary diagnosis, drug discovery, personalized treatment, and health management, driving profound changes in the healthcare sector [1-3]. AI chatbots such as ChatGPT and DeepSeek have also gained extensive application in medical education, academic research, and content generation [4]. AI not only fundamentally alters the practice model of medicine but also brings significant innovative potential to higher medical education. Basic Clinical Skills, as a bridging course between medical theory and clinical practice, directly affects the formation of medical students' practical abilities, clinical thinking, and professional qualities. However, traditional clinical skills teaching has long faced bottlenecks such as insufficient classroom interaction, dull content, monotonous training scenarios, and lack of immediate feedback. The development of AI offers a feasible pathway to address these issues.

The establishment of AI literacy competency frameworks and expert consensus for medical students has provided a systematic assessment structure for AI education in this population [5]. On this basis, to further investigate medical students' perceptions and expectations regarding AI-empowered medical education—particularly in Basic Clinical Skills teaching—this study designed a

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corresponding questionnaire to evaluate contemporary medical students' acceptance of innovative AI-driven teaching models, and to offer directions and recommendations for curriculum reform.

II. SUBJECTS AND METHODS

A. Subjects

Using stratified sampling, a total of 5,300 five-year clinical medicine and related majors students from grades 2023 to 2025 at a medical university were selected as participants. A total of 5,145 valid questionnaires were returned, including 2,060 from the 2025 cohort, 1,694 from 2024, and 1,391 from 2023, yielding a response validity rate of 97%. In terms of sample composition, clinical medicine majors accounted for 99.13% and non-clinical medicine majors 0.87%, with clinical medicine being the predominant group; males comprised 39.55% and females 60.45%; grade distribution covered freshmen through juniors at 40.04%, 32.93%, and 27.04% respectively, which broadly reflects the general current status and needs of students across grades regarding AI-enhanced university teaching.

B. Research Tools and Methods

1) Questionnaire Design: The questionnaire was designed based on the "Survey Questionnaire on the Current Status of AI-Empowered University Teaching" developed by Qian Liang. It comprised two major parts: the AI Technology Cognition Scale and the Survey on the Current Status of AI-Empowered Clinical Skills Teaching, covering four modules—basic information, technology cognition scale, analysis of current teaching status, and prospects of AI-empowered medical education—aiming to reveal students' AI literacy levels, existing problems in clinical skills teaching, and future needs from multiple dimensions. Cronbach's α coefficients for all dimensions were >0.8 , indicating high internal consistency; KMO values were >0.7 , and Bartlett's test of sphericity was significant ($p<0.001$), suitable for factor analysis; cumulative variance explained exceeded 60%, demonstrating good construct validity.

2) Questionnaire Administration: The survey was conducted online via the "Wenjuanxing" platform. Electronic questionnaires were distributed to each class, covering various clinical specialty student groups.

3) Research Methods: A five-point Likert scale was used, with scores 1–5 corresponding to "strongly disagree," "disagree," "neutral," "agree," and "strongly agree," quantifying students' AI cognition levels and attitudes toward innovation in clinical skills teaching from multiple dimensions. Higher scores indicate higher AI literacy or greater recognition of curriculum innovation.

4) Statistical Methods: Data were analyzed using SPSS 27.0 and AMOS 26.0. For count data, frequencies and percentages were used, and group comparisons were performed using chi-square tests. For continuous data, mean $\pm$ standard deviation ($\bar{X} \pm S$) were reported, and group comparisons used t-tests and one-way ANOVA. Two-sided $P<0.05$ was considered statistically significant.

III. RESULTS

A. Analysis of Students' AI Literacy

1) Grade-Based Difference Analysis: Results showed significant differences across grades in the dimensions of "technology understanding" ($p<0.001$) and "technology mastery" ($p<0.001$), with sophomores and juniors scoring higher overall than freshmen (see

Table I). Consistent with Qiong Zhou's study, the main reasons for grade differences lie in varying frequency of AI use and levels of AI education received among students ^[6], indicating that sophomores and juniors have higher AI usage and educational exposure than freshmen.

Table I. Grade-based Difference Analysis (ANOVA) of Structural Scale Scores

Dimension	Freshmen	Sophomores	Juniors	F value	p value
Technology understanding	3.5231	3.7705	3.7195	22.004	<0.001
Technology mastery	3.5623	3.8163	3.7356	23.355	<0.001
Application attitude	4.0272	4.0267	3.9731	4.83	<0.001

2) Descriptive Analysis: Overall statistical analysis of 5,141 valid questionnaires showed data conforming to normal distribution. Results revealed uneven development across dimensions of medical students' overall AI literacy: the "application attitude"

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dimension scored highest ($\bar{X}=4.01$), followed by "technology cognition" ($\bar{X}=3.97$), while "technology understanding" ($\bar{X}=3.65$) and "technology mastery" ($\bar{X}=3.69$) scored lowest. The dimensions exhibited non-synergistic development (see *Table II*).

Table II. Descriptive Statistics of AI Structural Scale (N=5141)

Dimension	Mean ($\bar{X}$)	Standard Deviation (S)
Technology understanding	3.6564	0.89656
Technology cognition	3.9729	0.79741
Technology mastery	3.6915	0.85379
Application attitude	4.0109	0.76362

B. Survey on Current Status of Clinical Skills Teaching

1) Satisfaction with Traditional Teaching Model and Student Interest: Over 70% of students reported being "very interested" or "relatively interested" in clinical skills, with only 1.6% indicating "not very interested" or "not at all interested." The mean Likert score was 4.14, higher than the general level reported for application-oriented undergraduate institutions ^[7] (see Figure 1). Regarding satisfaction with current teaching quality, the combined proportion of "very satisfied" and "relatively satisfied" was approximately 89.53%, with only 0.97% rating as "not very satisfied" or "very dissatisfied," and a mean score of 4.38, higher than comparable traditional teaching studies ^[8] (see Figure 2). These results indicate a solid foundation of student interest and classroom engagement.

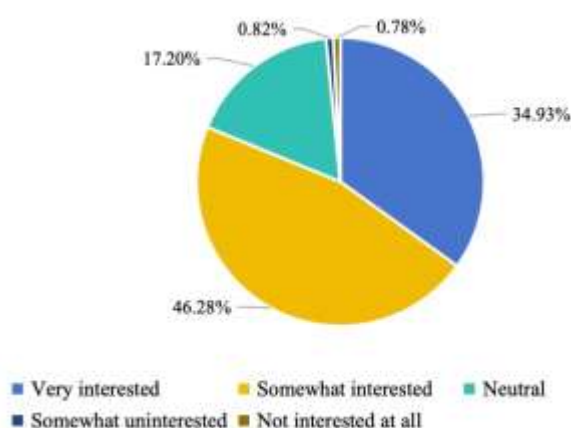


Figure 1. Students' evaluation of current clinical skills teaching

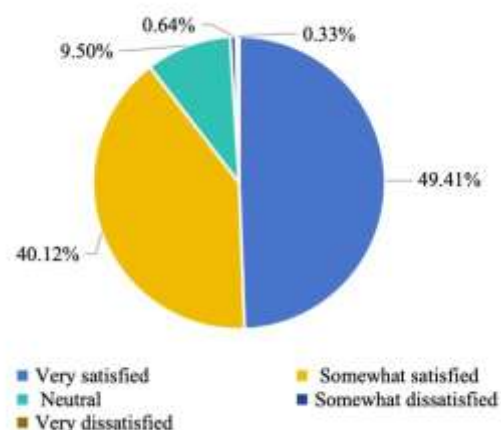


Figure 2. Student interest in current clinical skills

2) Pain Points and Improvement Suggestions for Basic Clinical Skills: In feedback on traditional teaching problems, "monotonous teaching methods" (about 48%) and "lack of practical sessions" (about 44%) were identified as core pain points, followed by "dull course content" (about 35%), providing a clear context for AI intervention (see Figure 3). Regarding curriculum optimization, students prioritized "increasing practical case analysis" (about 42%), followed by "conducting social practice activities" (about 31%) and "pedagogical innovation" (about 18%). This supports the subsequent integration of Problem-Based Learning (PBL), Case-Based Learning (CBL), and community service practice into Basic Clinical Skills teaching (see Figure 4).

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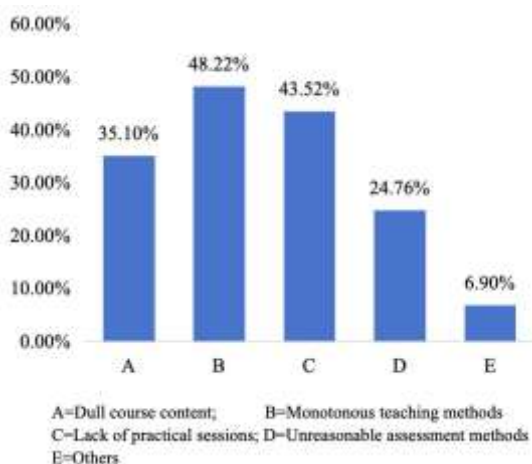


Figure 3. Pain points in clinical skills teaching

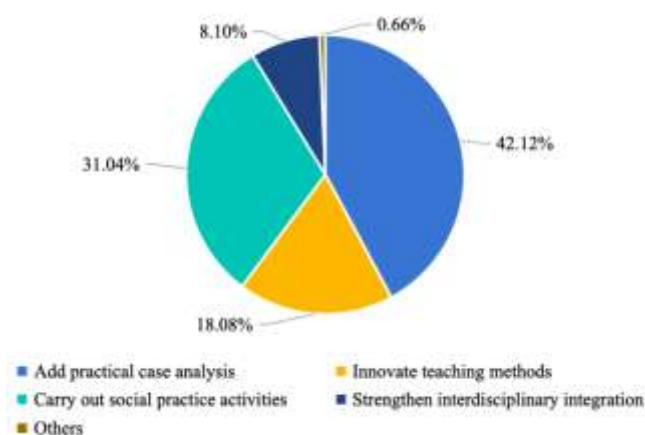


Figure 4. Students' suggestions for current clinical skills teaching

3) Current Application of AI Technology in Teaching: The survey showed that 58.8% of students explicitly stated that teachers had applied AI technology in clinical skills teaching, 34.74% were "uncertain," and only 6.46% answered "no," indicating that the university already has some AI teaching foundation (see Figure 5). Among the technologies applied, tool-type applications such as "intelligent Q&A systems" (about 60.28%) and "online interactive platforms" (about 58.84%) accounted for relatively high proportions, while deep applications like "personalized learning recommendations" (about 54.56%) and "data analysis and learning assessment" (about 48.28%) were lower, reflecting that AI application remains at a shallow Q&A level (see Figure 6).

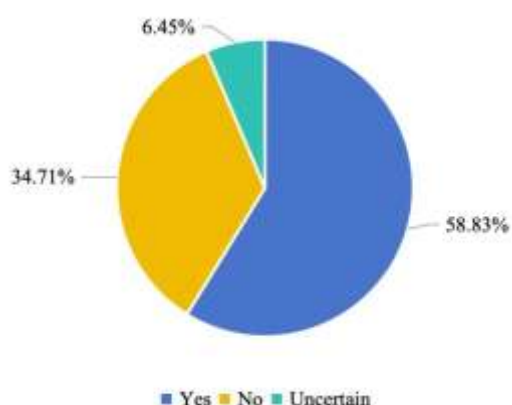


Figure 5. Proportion of teachers using AI in teaching

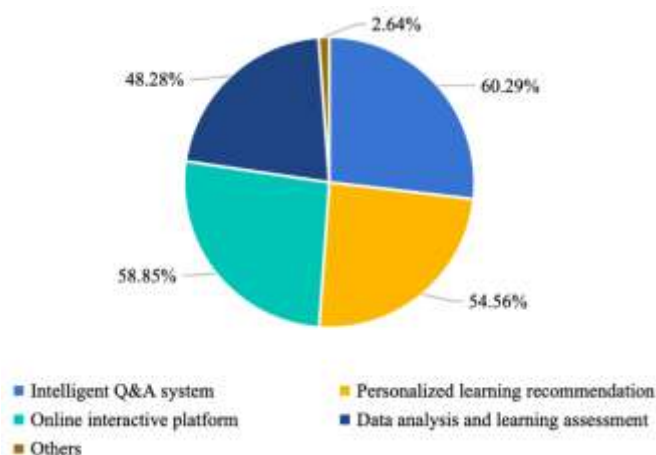


Figure 6. Distribution of AI application forms

4) Students' Expectations and Attitudes toward AI Teaching: The most desired roles of AI among students were: "providing personalized learning resources" (about 79%), "intelligent analysis of learning data to optimize teaching strategies" (about 68%), and "enhancing classroom interactivity" (about 65%) (see Figure 7). Regarding application prospects, over 84% of students expressed "very optimistic" or "relatively optimistic" attitudes (see Figure 8).

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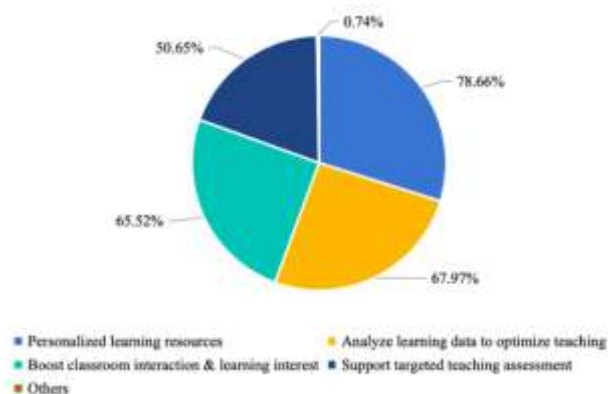


Figure 7. Student expectations for AI roles

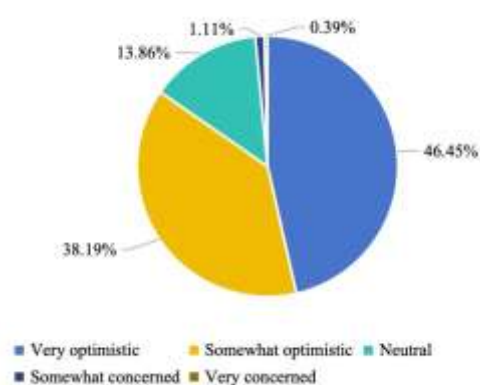


Figure 8. Student attitudes toward AI in clinical skills

5) Perceived Major Challenges: The main challenges perceived by students included: "insufficient technological maturity" (about 46%), "difficulty in teaching empowerment technology" (about 28%), and "student privacy protection issues" (about 17%), reflecting multifaceted concerns about technology itself, ethical risks, and implementation subjects (see Figure 9).

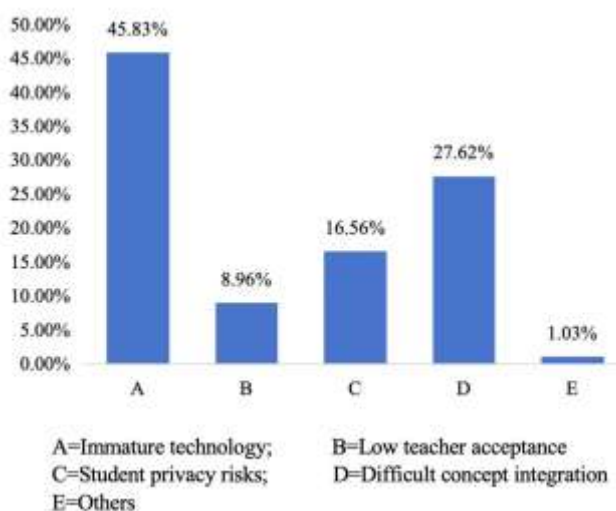


Figure 9. Perceived challenges of AI application in clinical skills teaching from students' perspective

IV. DISCUSSION

A. Current Status of "AI+Medical Education" Research from the Perspective of AI Literacy Analysis

As AI literacy assessment systems become increasingly refined, AI is rapidly reshaping the landscape of higher education. In the medical field, the impact of AI on medical students and medical education has been extensively studied [9]. Empirical research demonstrates that AI has significant effects in achieving personalized learning and enhancing student autonomy and self-confidence. For example, Gligorea and Cioca's review pointed out that AI-driven adaptive learning systems, which dynamically adjust teaching content based on learner feedback, can significantly improve academic performance [10]. However, research on how to integrate AI literacy frameworks into curricular practice and how to effectively incorporate AI into existing courses remains relatively scarce.

This study found that medical students generally hold positive attitudes toward AI-empowered teaching (application attitude $\bar{x}=4.01$), recognizing AI as a necessary trend that can enhance learning interest. Combined with Huan Li's analysis of learning motivation, the good interest of these medical students in Basic Clinical Skills may stem from the course's effectiveness, practicality, and importance as a required practical course for medical students [11]. However, students' actual technical mastery ($\bar{x}=3.69$) lags behind. This lag is not only related to deficiencies in curriculum design but also to the traditional teaching model that "emphasizes knowledge over skills and theory over practice." Students can recognize the value of AI but find it difficult to master AI tools, making this the primary obstacle for technology empowerment to move from concept to practice. Meanwhile, the uneven development of AI literacy dimensions aligns with Fengrong Yang's study on the formation mechanism of college students' AI literacy, which divides the formation into three stages: tool adaptation, cognitive restructuring, and identity

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integration^[12]. Medical students as a whole are in the tool adaptation and cognitive restructuring stages, with preliminary development of AI technology and application abilities, focusing on task completion and establishing trust and a sense of security in using the technology—this explains why "application attitude" and "technology cognition" scores are higher than "technology understanding" and "technology mastery." Furthermore, current AI teaching tools are mostly used at auxiliary levels such as intelligent Q&A and online interaction, while students have strong demands for "personalized learning recommendations" and "intelligent analysis of learning data," creating a sharp contrast with the current situation^[13]. The disconnect between technology application and students' core needs makes AI more of a "decoration" than an "engine."

B. Model Innovation and Challenges in Clinical Skills Teaching Practice

Traditional teaching surveys indicate that traditional clinical skills courses in universities suffer from dull teaching methods, poor classroom interactivity, and insufficient teaching resources and faculty, making it difficult to meet the demands of modern medical education^[14]. Students universally call for more practical cases and activities, reflecting a desire for "contextualized learning." Although there has been considerable discussion on the challenges and shortcomings of integrating AI into medical education^[15,16], concrete plans for how to integrate AI into existing courses remain scarce. Currently, cutting-edge reforms in clinical skills teaching focus on generative AI and virtual reality^[17,18]. AI-empowered virtual simulation technology should ideally be a major tool to address practical teaching problems, but in reality, virtual simulation teaching may degenerate into another form of "watching demonstrations," failing to effectively combine with authentic clinical reasoning training and emergency response development. Current mainstream AI technologies (rule- and data-based algorithms) excel at handling standardized, procedural tasks. The limitations of technical tools mean that AI empowerment often stays at the level of knowledge transmission and simple operational scoring, hardly touching the core of clinical competency development, while also potentially causing students to lose flexibility and failing to fully leverage the freedom and personalization that AI can offer.

C. Curriculum Optimization Pathways for AI-Enhanced Clinical Skills Teaching for Medical Students

Previous studies have pointed out that medical education urgently needs to improve students' AI knowledge systems, interpretive abilities, and application levels^[19], highlighting the importance of mastering AI practical skills required for future career development. This study found that medical students have insufficient technical understanding and cognition, and that medical education suffers from poor classroom flexibility. In this context, conducting AI literacy training for educators and students and innovating traditional teaching models will be key links in effectively addressing these challenges. Institutions have the responsibility to build a sound framework to ensure that AI tools complement traditional teaching methods and enhance student learning experiences^[20]. Regarding solving the problem of insufficient technical understanding and cognition, research suggests that personalized learning is a key strategy for cultivating AI literacy in higher education, and educators and policymakers should provide diverse learning resources to meet different needs^[21]. Therefore, in subsequent Basic Clinical Skills and AI-integrated innovative classroom models, more diversified and personalized AI teaching models and scenario-based interactions can be adopted to promote students' AI literacy development toward the next formation stage. At the same time, to address insufficient classroom flexibility, it is recommended to incorporate PBL and CBL pedagogies into Basic Clinical Skills teaching and extend the course to social practice components, thereby leveraging students' subjective initiative as a core functional goal of AI, liberating classroom freedom, and providing a more authentic clinical skills experience.

V. CONCLUSIONS

Currently, clinical skills teaching faces the dual bottlenecks of monotonous teaching methods and insufficient hands-on training. Although AI technology has been preliminarily introduced, it largely remains at shallow applications such as intelligent Q&A and online interaction, without deeply penetrating key areas like personalized learning recommendations and intelligent data analytics. However, students' actual expectations are precisely focused on these deep applications: over 84% of students hold positive attitudes toward AI and look forward to personalized resource recommendations, intelligent data analysis, and enhanced classroom interactivity. More notably, existing AI tools already have a certain penetration rate, providing a feasible foundation for building innovative teaching models. Nevertheless, issues such as insufficient technological maturity, unclear pathways for teaching empowerment, and privacy protection still constitute realistic obstacles.

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