Journal of Contemporary Educational Research, 2026, Volume 10, Issue 10
https://bbwpublisher.com/journal/JCER
Online ISSN: 2208-8474
Print ISSN: 2208-8466

Study on the Application Effect of Generative AI-Driven Blended Taeaching Model in the Systematic Course of Tumor Metastasis

Lei Hou, Xin Chen*

Shaanxi Provincial People's Hospital, Xi'an 710068, Shaanxi, China

***Corresponding author:** Xin Chen, 286017423@qq.com

Copyright: © 2026 Author(s). This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0), permitting distribution and reproduction in any medium, provided the original work is cited.

Abstract: *Objective:* To explore the application effect of the blended teaching model driven by generative artificial intelligence (GenAI) in the systematic course of tumor metastasis. *Methods:* Sixty-six master's degree students majoring in clinical medicine who participated in the standardized residency training at a medical college from September 2023 to September 2024 were selected and divided into an experimental group (33 students) and a control group (33 students) using a random number table method. The control group adopted conventional blended teaching, while the experimental group introduced GenAI tools on the basis of conventional blended teaching, which were used for personalized pre-class preview, in-class situational case generation and intelligent Q&A, post-class personalized consolidation, and formative assessment feedback. After the course, the theoretical assessment scores, case analysis scores, self-directed learning ability, critical thinking disposition, and teaching satisfaction were compared between the two groups. *Results:* There were no statistically significant differences in the basic data between the two groups of students (all $P > 0.05$). The theoretical assessment, case analysis, and overall evaluation scores, the scores of each dimension and total score of SLAS, the scores of each dimension and total score of CTDI-CV, and the teaching satisfaction rate in the experimental group were all higher than those in the control group (all $P < 0.05$). *Conclusion:* GenAI-driven blended teaching can improve learning performance in the systematic course of tumor metastasis, promote the development of self-directed learning ability and critical thinking, and achieve high student satisfaction, demonstrating value for promotion and application.

Keywords: Generative artificial intelligence; Blended teaching; Tumor metastasis; Medical education

Online publication: November 19, 2026

1. Introduction

Tumor metastasis is the leading cause of death from malignant tumors and a difficulty in oncology teaching. The incidence of tumors in China continues to rise, and non-oncology clinical graduate students

and residency-training physicians will also frequently encounter tumor-related cases in their daily clinical work, which places higher requirements on their tumor-related knowledge and clinical ability training. The mechanisms of metastasis involve the tumor microenvironment, epithelial-mesenchymal transition, and organ-specific colonization, while its diagnosis and treatment cover multiple sections such as imaging, pathology, and internal and external medicine, testing students' knowledge integration and clinical decision-making abilities. Under the traditional one-way lecture model, students passively receive knowledge and struggle to construct a complete cognitive chain of "mechanism-diagnosis-treatment," resulting in limited teaching effectiveness. Blended teaching, combining online self-study with offline discussion, has been widely applied in medical education. A meta-analysis of 77 studies by Wang *et al.* [1] confirmed that blended teaching is superior to traditional lecturing in terms of theoretical mastery and ability cultivation. The rapid development of generative AI, such as ChatGPT, provides a new path for personalized instructional design, clinical scenario simulation, and instant feedback [2]. Relevant studies suggest that AI drives medical education from a teacher-student binary structure to a "teacher-intelligent tool-student" ternary model, possessing application potential in curriculum design, case construction, and process evaluation [3]. Medical students generally recognize AI-assisted learning but are concerned about information bias and tool dependence [4]. The course of tumor metastasis is characterized by dense knowledge points and large logical spans, which fits the application scenarios of AI teaching. Although conventional blended teaching achieves the combination of online and offline, there are still shortcomings in personalized resource adaptation, real-time classroom interaction, and refined evaluation. At present, empirical studies on integrating generative AI into blended teaching and systematically evaluating its effects are scarce. Using conventional blended teaching as a control, this study conducted an AI-driven blended teaching practice in the tumor metastasis course, evaluating the effects from three aspects: performance, ability, and satisfaction, to provide a reference for oncology curriculum reform.

2. Subjects and methods

2.1. Research subjects

Sixty-six master's degree students majoring in clinical medicine who participated in the standardized residency training at a medical college from September 2023 to September 2024 were selected as the research subjects. The students were divided into an experimental group and a control group using a random number table method, with 33 students in each group. The differences in gender, age, and the average score of the medical comprehensive examination in the postgraduate entrance examination between the two groups were not statistically significant ($P > 0.05$), indicating comparability.

Inclusion criteria: Clinical master's degree students (residency-training trainees) who fully participated in the course teaching and completed all assessments. Exclusion criteria: Those with cumulative absent hours exceeding 10% of the total course hours, or those who failed to complete all evaluation scales.

2.2. Course settings

The course consists of 32 credit hours in total, including 12 credit hours of online self-study and 20 credit hours of offline classroom teaching. The main content includes six units: basic concepts and epidemiology of tumor metastasis, molecular mechanisms of metastasis, organ-specific metastasis, diagnosis and evaluation of metastasis, comprehensive treatment strategies, and typical case discussions. The course adopts a small-

class teaching organization format, with the two groups of students taught in separate classes to avoid the impact of inter-group communication on the evaluation of teaching effectiveness. The instructors, textbooks, and assessment requirements for the two groups of students were kept consistent.

2.3. Teaching methods

The control group adopted a traditional blended teaching model. Before class, students relied on online platforms to watch micro-lessons and complete pre-learning quizzes; during class, teachers used multimedia to lecture on key theoretical points, organized group discussions on typical cases, and summarized the content; after class, students completed online exercise training, and teachers set fixed time slots for online centralized Q&A, without using generative artificial intelligence (AI) tools throughout the process.

The experimental group implemented generative AI-empowered blended teaching. (1) Pre-class tiered pre-learning: Based on learning condition data, teachers used large models to customize pre-learning task sheets and knowledge graphs, pushing micro-lessons and extension materials targeted at the knowledge weak points of standardized residency training graduate students from different specialty backgrounds. (2) In-class situational inquiry: Following the process of "AI-created scenarios—problem chain guidance—group collaborative discussion—instant feedback," AI was used to generate multi-branch clinical cases, such as a comprehensive diagnosis and treatment case of breast cancer bone metastasis; students worked in groups to formulate diagnosis and treatment plans, AI teaching assistants answered questions and inspired clinical critical thinking, and teachers provided final reviews. (3) Post-class targeted consolidation: AI generated personalized exercises and error analysis based on answering data, and pushed extension cases; students could use AI virtual patients to conduct inquiry communication training [5]. (4) Closed-loop formative evaluation: AI integrated learning data to generate personal learning condition reports for reference by teachers and students, and teachers dynamically adjusted teaching plans. In teaching, AI was regarded as an auxiliary means, all AI-generated content was reviewed by teachers, and students were guided to rationally distinguish AI results. Before class, teachers were organized to conduct special training on AI tools and prompts, a course-specific AI teaching assistant platform was built, and the knowledge base scope was limited to reduce problems of content deviating from teaching objectives.

2.4. Evaluation indicators

(1) Assessment scores: After the course, a unified closed-book theoretical assessment (total score of 100) and a standardized case analysis assessment (total score of 100, scored independently by two teachers according to scoring criteria and averaged) were conducted. The two scores were weighted at 60% and 40% to calculate the overall score.

(2) Self-directed learning ability: The Self-Directed Learning Ability Scale (SLAS) compiled by Lin *et al.* and widely used in previous studies [6] was adopted, including 3 dimensions of self-management ability, information ability, and learning cooperation ability with a total of 28 items, using Likert 5-point scoring, with a total score of 28–140.

(3) Critical thinking disposition: The Chinese version of the Critical Thinking Disposition Inventory (CTDI-CV) revised by Peng *et al.* [7] was adopted, containing 7 dimensions and 70 items, using Likert 6-point scoring, with a total score of 70–420.

(4) Teaching satisfaction: A self-compiled questionnaire by the research group was used to evaluate aspects

such as course content, teaching format, and learning gains, divided into three levels: satisfied, average, and unsatisfied, and compared using the satisfaction rate (proportion of satisfied individuals to the total number).

2.5. Statistical methods

SPSS 27.0 software was used for statistical analysis. Measurement data were expressed as mean ± standard deviation (SD), and comparisons between groups were performed using the *t*-test; count data were expressed as [*n* (%)] and comparisons between groups were performed using the χ^2 test. $P < 0.05$ was considered statistically significant.

3. Results

3.1. Comparison of general information between the two groups of students

The differences in the comparison of basic information between the two groups of students were not statistically significant (all $P > 0.05$), see **Table 1**.

Table 1. Comparison of general characteristics between two groups of students

Item	Experimental group (n = 33)	Control group (n = 33)	t/χ^2	P
Male/Female (cases)	18/15	16/17	0.243	0.622
Age (years, mean ± SD)	21.16 ± 0.83	21.24 ± 0.81	0.348	0.729
Average prior course grade (points, mean ± SD)	79.48 ± 5.16	79.96 ± 5.03	0.382	0.704

3.2. Comparison of assessment scores between the two groups of students

The experimental group had higher scores in the theoretical assessment, case analysis, and overall evaluation compared to the control group (all $P < 0.001$), see **Table 2**.

Table 2. Comparison of assessment scores between the two groups of students

Item	Experimental group (n = 33)	Control group (n = 33)	t	P
Theoretical Assessment	87.42 ± 5.36	82.15 ± 6.28	3.657	<0.001
Case Analysis	84.68 ± 6.12	78.53 ± 7.24	3.735	<0.001
Overall Grade	86.35 ± 5.02	80.74 ± 6.15	4.053	<0.001

3.3. Comparison of self-directed learning ability scores between the two groups of students

The scores for each dimension and the total score of the SLAS in the experimental group were all higher than those in the control group (all $P < 0.01$), see **Table 3**.

Table 3. Comparison of self-directed learning ability scores between the two groups of students

Dimension	Experimental group (n = 33)	Control group (n = 33)	t	P
Self-management ability	32.46 ± 3.52	29.15 ± 3.89	3.620	<0.001
Information ability	34.28 ± 3.75	31.02 ± 4.13	3.343	<0.001
Learning cooperation ability	22.68 ± 2.84	20.47 ± 3.06	3.027	0.004
Total score	89.42 ± 8.67	80.64 ± 9.53	3.919	<0.001

3.4. Comparison of critical thinking disposition and teaching satisfaction between the two groups of students

The experimental group had higher scores on all dimensions of the CTDI-CV than the control group (all $P < 0.05$); the teaching satisfaction rate of the experimental group was higher than that of the control group ($P < 0.05$), as shown in **Tables 4** and **5**.

Table 4. Comparison of critical thinking disposition scores between the two groups of students

Dimension	Experimental group (n = 33)	Control group (n = 33)	t	P
Truth-seeking	44.12 ± 5.28	41.36 ± 5.61	2.056	0.044
Systematic ability	43.15 ± 4.92	40.38 ± 5.24	2.208	0.031
Intellectual curiosity	45.62 ± 4.87	43.05 ± 5.12	2.087	0.041
Total score	314.26 ± 18.35	298.31 ± 20.42	3.335	0.001

Table 5. Comparison of teaching satisfaction between two groups of students [n (%)]'

Group	Satisfied	Neutral	Dissatisfied	Satisfaction rate (%)
Experimental group (n = 33)	31(93.9)	2(6.06)	0(0)	31(93.94)
Control group (n = 33)	25(75.76)	6(18.18)	2(6.06)	25(75.76)
χ^2				4.243
P				0.039

4. Discussion

This study integrated generative artificial intelligence into blended teaching, conducting a specialized course on tumor metastasis—characterized by numerous knowledge points and strong logical correlations—for clinical master's degree standardized residency training students from diverse professional backgrounds. The results showed that the experimental group outperformed the control group in theoretical tests, case analyses, and overall grades, demonstrating that generative AI-empowered blended teaching can effectively improve the tumor-related knowledge learning outcomes for clinical graduate students in non-oncology specialties during their residency training. This conclusion aligns with existing literature: Rong *et al.* [8] found that ChatGPT-assisted CBL teaching can streamline students' pre-class preparation workload and improve learning efficiency; Zeng *et al.* [9] confirmed that ChatGPT's involvement in PBL teaching helps enhance the theoretical proficiency and clinical management capabilities of clinical medical students. Under the clinical residency training system, graduate students in specialties such as respiratory medicine, gastroenterology, and general surgery frequently encounter cases related to tumor metastasis in their daily practice, yet they lack systematic and comprehensive training in the knowledge framework of tumor metastasis. Generative AI provides support for implementing the student-centered concept: before class, it generates personalized preview materials and knowledge frameworks based on learning conditions, guiding students to engage in class with inquiries; during class, multi-branch clinical cases transform abstract metastasis mechanisms into real diagnostic and treatment scenarios, facilitating knowledge internalization and transfer; AI teaching assistants provide real-time feedback, compensating for the insufficient interactivity of traditional classrooms. Meanwhile, AI alleviates teachers' burden of tiered lesson preparation, freeing up classroom time for in-depth discussions and constructing a teaching model of "teacher-led, AI-assisted, student-centered," which is

consistent with the findings of case-oriented teaching research in oncology courses [10].

Self-directed learning ability is a core competency for residency graduate students to complete clinical rotations and achieve post competence. In this study, the experimental group scored higher than the control group across all dimensions and on the total score of the SLAS scale, indicating that this teaching model can cultivate students' self-directed learning abilities. Personalized learning materials and learning condition reports help students grasp their learning status and strengthen self-management; AI error analysis and expanded resources reduce the difficulty of self-directed learning, encouraging students to autonomously plan their learning pace. Relevant studies also indicate that informatized blended teaching has a positive effect on fostering self-directed learning abilities.

The diagnosis and treatment of tumor metastasis often require comprehensive weighing under limited information, posing high demands on the critical thinking of residency graduate students across various specialties. The results of this study show that the experimental group's total CTDI-CV score, as well as scores in dimensions such as truth-seeking, systematic ability, and curiosity, were superior to those of the control group. This is attributed to the "multi-branch decision-making—dialectical review" teaching segment designed in the curriculum. AI-constructed cases contain multiple feasible decision pathways, prompting students to compare clinical evidence, weigh the pros and cons of different options, and complete argumentation; instructors simultaneously guide students to screen AI outputs, identify algorithmic limitations and potential biases, and train critical thinking in practical scenarios. The study iteratively adjusted prompts to control the difficulty of AI questioning, preventing open-ended critical thinking tasks from solidifying into templated responses. Existing literature expresses concerns that the overuse of generative AI may weaken independent thinking abilities; however, this study confirms that under scientific instructional design and effective guidance, AI can serve as a powerful tool for cultivating critical thinking in clinical residency graduate students.

Teaching satisfaction in the experimental group was significantly higher than in the control group. Students generally perceived AI case scenarios as closely resembling clinical practice, with rapid feedback responses and a superior personalized learning experience. Unlike undergraduate education, residency graduate students place greater emphasis on the guiding value of course content for actual clinical work. The course introduced AI virtual standardized patients for consultation and doctor-patient communication training, compensating for the shortcoming of insufficient standardized patient supply in traditional teaching, and relevant literature has also confirmed the application value of such virtual cases in history-taking training. In this model, the teacher's role shifts from a knowledge lecturer to a learning scenario designer and learning guide, aligning with the trend of digital transformation in medical education.

This study still has limitations: it is a single-center study with a limited sample size, restricting the generalizability of the conclusions; the observation period was only one semester, failing to track the long-term retention of teaching effects; both self-directed learning and critical thinking were assessed using self-report scales, which are subject to subjective bias; the selection of AI tools and prompt writing affect teaching outcomes, and the efficacy differences among different tools need further comparison. Ethical issues such as AI content reliability, risks of students' tool dependency, and data privacy still require continuous attention. Future plans include expanding the sample size, extending follow-up periods, and exploring the deep integration of AI literacy education with specialized courses to accumulate evidence for the standardized application of AI in medical classrooms.

5. Conclusion

In summary, adopting generative AI-empowered blended teaching in the tumor metastasis course can improve students' academic performance, develop self-directed learning and critical thinking, and achieve high teaching satisfaction, making it suitable for promotion in oncology-related courses. However, the efficacy of AI teaching relies on the synergistic coordination of tool selection, content review, and instructional design, requiring technology empowerment to be anchored in achieving teaching objectives; during teaching implementation, AI content verification should be conducted rigorously to prevent over-reliance by students, while AI literacy and ethics education should be implemented concurrently.

Disclosure statement

The authors declare no conflict of interest.

References

[1] Wang X, Wei C, Wang X, et al., 2024, Meta-Analysis of the Application Effects of Blended Teaching in Medical Education in China. Chinese Journal of Medical Education, 44(7): 517–522.

[2] Qu X, Yang J, Chen T, et al., 2023, Reflections on the Transformation of Medical Education Models by ChatGPT. Journal of Sichuan University (Medical Science Edition), 54(5): 937–940.

[3] Song Y, Li Z, Ding N, 2024, Analysis of the Impact of Generative Artificial Intelligence on Medical Education. China Medical Education Technology, 38(3): 281–286.

[4] Yuan Z, Pei Z, Lin J, et al., 2025, Medical Students' Perceptions of Integrating Generative Artificial Intelligence into Medical Education. Medicine and Philosophy, 46(14): 52–57.

[5] Chen N, Tang L, Huang X, et al., 2025, Applied Research of Virtual Standardized Patients Based on ChatGPT-4. Chinese Journal of Medical Education, 45(1): 44–49.

[6] Yan H, Yang C, Dong P, et al., 2025, Application of Blended Teaching Model Based on BOPPPS in the "Adult Nursing" Course. Journal of Kunming Medical University, 46(7): 175–180.

[7] Peng M, Wang G, Chen J, et al., 2004, Study on the Reliability and Validity Testing of the Critical Thinking Disposition Inventory. Chinese Journal of Nursing, 39(9): 644–647.

[8] Rong X, Xu M, Zhou Y, et al., 2025, Application of ChatGPT-Assisted Case-Based Learning Teaching in Anesthesiology Teaching for Eight-Year Clinical Medicine Students. Chinese Journal of Medical Education, 45(8): 610–615.

[9] Zeng H, Zhu Z W, Hu J, et al., 2025, Application of ChatGPT-Assisted Problem-Based Learning Teaching Method in Clinical Medical Education. BMC Medical Education, 25: 50.

[10] Li M, Liu Y, Fan L, et al., 2024, Application of CBL Combined with PBL in Oncology Bioinformatics Teaching. Chinese General Practice, 22(3): 500–503.

Publisher's note

Bio-Byword Scientific Publishing remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.