Research Square

Preprints are preliminary reports that have not undergone peer review.
They should not be considered conclusive, used to inform clinical practice,
or referenced by the media as validated information.

Teaching Practice and Pedagogical Reform of Basic Medical Courses for Intelligent Medical Engineering Majors Under Cross-Institutional Integration

Weiwei Yang
Harbin Medical University
Fengyan Xu
Harbin Medical University
Yan Yan
Harbin Medical University
Yanshuang Wu
Harbin Medical University
Yingli Song
Harbin Medical University
Bo Cao
caobo@hrbmu.edu.cn
Harbin Medical University

Research Article

Keywords: Cross-institutional integration, Intelligent Medical Engineering, Introduction to Basic Medicine, Interdisciplinary talent cultivation, Full-cycle teaching reform, Diversified assessment

Posted Date: August 19th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-10622900/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License.
Read Full License

Additional Declarations: No competing interests reported.

Teaching Practice and Pedagogical Reform of Basic Medical Courses for Intelligent Medical Engineering Majors Under Cross-Institutional Integration

Weiwei Yang[1] , Fengyan Xu[1] , Yan Yan[1], Yanshuang Wu[1] , Yingli Song[1] , Bo Cao[1,2*]

[1] Harbin Medical University, Harbin, China, No.157 Baojian Road

[2] Harbin Medical University (Daqing Campus), Daqing, China, No. 39 Xinyang Road

*Correspondence: Bo Cao, Harbin Medical University, E-mail: caobo@hrbmu.edu.cn

Abstract

Background: The integration of artificial intelligence, big data and other engineering technologies with clinical medicine has spawned the interdisciplinary major of Intelligent Medical Engineering, which requires compound talents with medical literacy, engineering capabilities and innovative thinking. The course Introduction to Basic Medicine is the core foundational curriculum of this major, yet it is a newly launched course without mature teaching paradigms and supporting experimental teaching systems. Traditional pure medical basic teaching models fail to match the cognitive characteristics and training goals of engineering-background students. This study constructs and implements a full-cycle teaching reform framework oriented toward medical-engineering interdisciplinary integration, aiming to systematically build students' medical knowledge system, cultivate interdisciplinary thinking, and improve independent learning and practical innovation abilities. Methods: This research adopts action research combined with quasi-experimental practice. The teaching reform mainly includes two core innovations: integrated reconstruction of interdisciplinary course content and construction of a closed-loop teaching model covering pre-class preparation, in-class interactive teaching and post-class layered consolidation. A diversified evaluation system combining formative assessment and summative examination was designed. Multiple evaluation indicators including student academic performance, questionnaire reliability testing, classroom participation statistics and post-class interview feedback were used to measure teaching effectiveness. Results: The cross-school integrated teaching reform significantly improved students' autonomous learning efficiency, mastery of basic medical knowledge and interdisciplinary cognitive ability, and effectively solved the teaching bottlenecks of new interdisciplinary courses lacking reference experience. The study also identified existing limitations including insufficient depth of interdisciplinary practical links, inadequate differentiated layered teaching and vague formative assessment standards, and put forward targeted optimization strategies. Conclusion: The medical-engineering integrated full-cycle teaching model provides a replicable practical scheme for foundational medical teaching of cross-school joint training interdisciplinary majors, and offers reference for curriculum construction and pedagogical reform of emerging medical engineering disciplines.

Key words: Cross-institutional integration; Intelligent Medical Engineering; Introduction to Basic Medicine; Interdisciplinary talent cultivation; Full-cycle teaching reform; Diversified assessment

1. Introduction

With the deep integration of engineering technologies such as artificial intelligence and big data into the medical field, Intelligent Medical Engineering has emerged as an interdisciplinary discipline bridging medicine and engineering. Its core requirement is to cultivate interdisciplinary talents who "understand medicine, possess engineering expertise, and demonstrate innovative capabilities[1] ."Leveraging their respective disciplinary strengths, Harbin Institute of Technology and Harbin Medical University have jointly established the Intelligent Medical Engineering program. This initiative breaks down inter-university barriers, achieves complementary resources between engineering technology and medical education, and represents a significant measure to address industry demands and nurture specialized professionals.

"Introduction to Basic Medicine" serves as the inaugural core foundational course for students majoring in Intelligent Medical Engineering, covering essential medical disciplines such as human anatomy, physiology, pathology, and pharmacology. The teaching quality of this course directly impacts students' subsequent medical studies, their ability to integrate engineering technology with medical applications, and the development of professional competencies. As this program is newly established with entirelyFor this new curriculum, there is no prior teaching experience or experimental classes for reference. Moreover, students possess dual backgrounds in engineering and medical sciences, resulting in significantly different knowledge requirements compared to purely medical students. This course emphasizes the construction of systematic medical knowledge frameworks and the cultivation of medical thinking, rather than pursuing in-depth specialization in medical knowledge. Its core focus is laying a solid foundation for students to apply engineering techniques to solve medical problems.

Under these circumstances, exploring teaching methodologies tailored to interdisciplinary needs and aligned with student backgrounds has become the core mission of course instruction, as well as a key factor in enhancing the quality of interdisciplinary talent cultivation.

Focusing on teaching practices for novel interdisciplinary programs and foundational medical courses, this study explores innovative pedagogical approaches for basic medical education under the "engineering + medicine" integration framework. It

enriches the conceptual framework of interdisciplinary teaching methodology research in cross-institutional collaboration, addresses methodological gaps in teaching research for emerging disciplines lacking prior instructional experience, and provides theoretical references for foundational medical pedagogy studies in similar interdisciplinary programs through systematic analysis of teaching attempts and practical experiences. Against the backdrop of the "Introduction to Basic Medicine" course, this study clarifies instructional design principles and implementation pathways tailored specifically for the Intelligent Medical Engineering program. This approach addresses the teaching challenges of new courses characterized by "no existing experience to draw from and high requirements for precise adaptation," and effectively improves course quality. The research findings provide practical support for the subsequent curriculum construction of this discipline, help achieve the talent training goals of cross-institutional joint education programs, and offer replicable teaching references for basic medical education in similar emerging interdisciplinary fields.

First, clarify the talent training goals of the Intelligent Medical Engineering program and its requirements for the "Introduction to Basic Medicine" course. By integrating the new curriculum framework and the characteristics of the student source, the core design principles of teaching methods are proposed. Second, carry out the practice of teaching methods with a focus on content integration and innovative full-cycle teaching models. Third, evaluate the effect of teaching implementation on improving students' learning ability, knowledge acquisition and cognitive development. Finally, summarize the practical experience and limitations of teaching method optimization, and put forward actionable suggestions to form a complete teaching research conclusion. This study utilizes literature review methods to analyze talent cultivation requirements for Intelligent Medical Engineering programs and the current research status in basic medical education pedagogy. Employ action research methodologies combined with classroom teaching practices to continuously refine instructional content and pedagogical strategies. Collect student feedback and teaching effectiveness data through questionnaire surveys, academic performance analysis, and interviews, and employ both quantitative and qualitative approaches to assess implementation outcomes. Conclude with teacher reflection techniques to systematically identify best practices and challenges in teaching practices, thereby optimizing pedagogical design.

2. Methods

Leveraging the cross-institutional integration advantages of Harbin Institute of Technology and Harbin Medical University, as well as the "engineering-medicine integration" talent cultivation objectives of the Intelligent Medical Engineering program, the teaching methodology design addresses the characteristics of this unprecedented new curriculum and the unique background of enrolled students. The design adheres to four core principles: adaptability, systematicness, practicality, and innovation, with the central focus on "solidifying medical foundations, fostering interdisciplinary medical-engineering thinking, and enhancing applied competencies. Two key teaching initiatives are implemented: content integration and innovation in comprehensive teaching models, aiming to establish a distinctive pedagogical framework tailored to this emerging interdisciplinary discipline.

2.1 Participants

The teaching reform team comprises five cross-disciplinary instructors. All instructors completed standardized pre-reform interdisciplinary teaching training to ensure consistency in teaching standards and supervisory frameworks. The participating students are all enrolled in the undergraduate Intelligent Medical Engineering joint training program (including students from two cohorts since the course was first offered in 2025).

2.2 Curriculum Reform Design

Since the launch of the Intelligent Medical Engineering major, the research team has carried out curriculum reform and practice of Introduction to Basic Medicine, taking "medical-engineering interdisciplinary integration" as the core teaching concept. The overall reform covers three core dimensions: integrated reconstruction of teaching content, full-cycle innovation of pre-class-in-class-post-class teaching model, and optimization of the diversified comprehensive assessment system, with the core goal of breaking the separation of medical theory and engineering application and cultivating students' interdisciplinary comprehensive competencies (Figure 1).

The reform design was supported by three educational theories:

- Integration and Optimization of Teaching Content: Aligning with Interdisciplinary Needs and Strengthening Medical Fundamentals;
- Innovation in the Full-cycle Teaching Model: Stimulating Learning Initiative and Cultivating Comprehensive Abilities;
- Inquiry-based learning theory: Take engineering medical practical problems as the entry point to guide students to independently explore medical theoretical knowledge.

2.2.1 Integrated Reconstruction of Teaching Content

Breaking the traditional single-discipline medical curriculum setting logic, the content reconstruction follows the three core paths of core knowledge distillation, systematic framework reorganization and interdisciplinary embedding:

- Precise distillation of core medical knowledge: Screen anatomy, physiology, histoembryology and pathology content closely related to intelligent medical equipment, signal acquisition, and medical image recognition; delete overly complex clinical differential diagnosis and pure theoretical derivation to reduce learning burden and adapt to engineering students' cognitive rules.
- Systematic reorganization of knowledge framework: Abandon the segmentation of single medical disciplines, take human physiological systems as the main line to integrate multi-disciplinary knowledge. For example, build an integrated module of the cardiovascular system covering anatomical structure, physiological operation, pathological lesion characteristics and clinical drug intervention.
- Deep embedding of engineering interdisciplinary content: Combine medical theoretical knowledge with engineering technology application scenarios. When explaining physiological signal transmission, match sensor signal collection engineering cases; when teaching pathological lesion characteristics, embed Raman spectrum imaging [2], AI medical image recognition and other intelligent medical technologies to build a closed loop of "medical theory + engineering practice [3]".

Dynamic content optimization mechanism: Collect student feedback through post-class questionnaires and interviews, continuously supplement visual animation materials and simplified interdisciplinary engineering cases for difficult medical knowledge modules, and realize dynamic matching between curriculum content and students' learning needs.

2.2.2 Full-Cycle Pre-Class-In-Class-Post-Class Teaching Model

A three-stage closed-loop teaching framework was built to replace the traditional single-classroom lecture mode, with matching teaching strategies for each stage:

Pre-class preparation: Cultivate autonomous learning awareness

Rely on cross-school joint online teaching platforms to integrate medical and engineering digital resources, and design targeted preview tasks:

- Clear preview outlines to clarify key knowledge and difficult points;
- Rich visual learning resources including micro-lectures, medical animation, digital anatomy models;
- Open interdisciplinary inquiry questions requiring students to combine engineering knowledge to analyze simple medical problems.

Students complete preview materials and submit preliminary analysis online before class; teachers collect common confusion points through the platform to adjust classroom teaching focus. Pre-class completion quality is included in formative assessment (20% of total score) to constrain and guide autonomous learning habits.

In-class interactive inquiry teaching: Deepen interdisciplinary cognition

Classroom teaching is the core link of the reform, adopting multiple interactive teaching methods:

- Medical-engineering case integrated teaching: Combine clinical disease cases with intelligent medical equipment design demands to interpret medical mechanisms and engineering application logic simultaneously;
- Mixed group discussion: Divide students into mixed teams to discuss interdisciplinary topics such as "The working principle of brain-computer interfaces and their core underlying technologies," with teachers guiding summary and deduction;
- Real-time classroom quizzes: Small tests after each knowledge module, included in formative assessment (10% of total score), timely feedback on knowledge mastery gaps.

Post-class layered consolidation: Improve practical application ability

Design differentiated layered tasks and multi-dimensional extended learning links to realize hierarchical ability improvement:

- Tiered homework: Basic exercises for consolidating core medical concepts; advanced interdisciplinary design tasks requiring students to put forward engineering solutions for medical problems;
- Interdisciplinary practice projects: Literature review of intelligent medical technology, small medical engineering project proposal writing and defense, scored as 10% of formative assessment;
- Online long-term tutoring: Timely Q&A and personalized resource pushing on the teaching platform;
- Regular feedback collection: Post-class questionnaires and one-on-one interviews to collect teaching optimization suggestions.

2.2.3 Diversified Comprehensive Assessment System Design

Break the single final closed-book exam evaluation mode, construct a two-part assessment system of "formative assessment + summative examination," implement whole-process tracking evaluation of learning behaviors and comprehensive abilities, and formulate standardized scoring rubrics for each assessment link to ensure evaluation transparency and consistency.

Formative assessment (40% of total score):

- Pre-class preview completion and presentation quality: 20%;
- Module classroom quizzes: 10%;
- Interdisciplinary project report and defense: 10%. Evaluation dimensions cover autonomous learning initiative, collaborative inquiry ability, knowledge application and academic communication level.

Summative closed-book examination (60% of total score): Focus on systematic inspection of core medical knowledge and interdisciplinary analysis ability; reduce rote memorization questions, increase comprehensive case analysis questions that integrate medical theory and engineering application.

All scoring standards are formulated with reference to the joint training management manual of Harbin Institute of Technology and Harbin Medical University to ensure unified evaluation standards. Formative feedback runs through the whole semester, allowing students to revise and optimize tasks based on teacher and peer suggestions.

2.3 Specific Teaching Implementation Steps

Before the course officially started, cross-school teacher training and student pre-training workshops were held uniformly: Teachers received unified training on interdisciplinary teaching methods and formative assessment standards; students learned the use of online learning platforms, literature retrieval tools and interdisciplinary project writing specifications to lay a foundation for the smooth implementation of the reform. The complete implementation flow of the reformed teaching model is as follows:

- Pre-class task release and autonomous preview: Teachers publish preview outlines, digital resources and interdisciplinary inquiry questions on the cross-school online platform; students complete learning and submit online feedback; teachers sort out common difficult points.
- In-class dual-teacher interactive teaching: Combine case teaching, group discussion and real-time quizzes to interpret medical core knowledge and embedded engineering application scenarios, and organize targeted questioning and discussion.
- Post-class layered consolidation and interdisciplinary practice: Students complete tiered homework, finish intelligent medical literature reviews or small engineering project proposals, and submit results to the platform for teacher grading and feedback.
- Multi-dimensional whole-process assessment: Integrate pre-class, in-class and post-class performance into formative scores; carry out a final summative closed-book examination at the end of the semester.
- Teaching effect evaluation and dynamic optimization: Collect student questionnaires, teacher evaluation scales and academic performance data,

summarize teaching defects and adjust curriculum content and teaching links in real time.

2.4 Statistical Analysis

All quantitative data were sorted and analyzed using GraphPad Prism 10.4.0 software. Independent sample unpaired t-tests were used to compare academic scores between the performance of students over two terms; questionnaire statistical results were expressed as student proportion and average satisfaction score. The threshold of statistically significant difference was set as two-tailed $p < 0.05$. All data are presented in the form of Mean ± SD, combined with group comparison statistics and p-values.

3. Results

After the full-cycle medical-engineering integrated teaching model was implemented, we conducted a multidimensional assessment across three dimensions: learning ability, knowledge mastery level, and interdisciplinary cognitive development among students from two cohorts. Feedback from student questionnaires, teacher ratings, and comparative data on academic performance all indicate that this teaching model has yielded significant positive educational outcomes.

3.1 Significant Improvement of Students' Autonomous Learning Ability

Through the implementation of a comprehensive teaching model covering "pre-class preparation, in-class learning, and post-class review" alongside an innovative assessment system, students have demonstrated significant improvements in self-directed learning skills, collaborative inquiry abilities, and 1problem-solving capabilities. Teaching and assessment data show that as instructional practices progressed, pre-class preview completion rate increased from 78.2% (First Cohort of Students) to 95.3% (Second Cohort of Students); classroom active participation rate rose from 65.1% to 88.7% (Figure 2A); the average score of in-class module quizzes increased from 72.5 ± 4.12 to 83.7 ± 3.68, with statistically significant difference ($p < 0.001$) (Figure 2B). All students reported high frequency of active participation in online previews and classroom group discussions; more than 92.4% of students believed that the pre-class preview mechanism greatly improved their autonomous learning awareness. (Figure 2C)

The full-cycle teaching model guided students to take the initiative to construct a medical knowledge system matching engineering backgrounds, and the pre-class preview link effectively stimulated students' sense of independent inquiry.

3.2 Stable Improvement of Students' Mastery of Basic Medical Knowledge

Through the integration and optimization of teaching content, implementation of a

comprehensive teaching methodology, and adoption of innovative assessment systems, students' foundational medical knowledge systems have been progressively refined, with steady improvements in knowledge mastery. Course performance data reveals that students' average grades (comprising process evaluations and final examinations) increased from an initial 73.22 points to 80.06 points ($p < 0.001$) (Figure 3A), demonstrating a consistent upward trend. The excellence rate (scores above 85) rose from 16.3% to 27.0% (Figure 3B), indicating deepening comprehension and retention of instructional materials. The application of pedagogical approaches and assessment frameworks has effectively enhanced knowledge delivery efficiency and learning outcomes.

Questionnaire feedback (n=92, Table 1): 95.7% of students believed that the integrated medical-engineering curriculum framework helped them build a systematic basic medical knowledge system; 88.0% of students thought the visual teaching materials and interdisciplinary cases reduced the difficulty of learning abstract medical knowledge; 90.2% of students reported that they had mastered core medical theories required by subsequent professional courses (Figure 3C). The reconstructed content system avoids fragmented medical knowledge learning, and the embedded engineering application cases strengthen students’ deep understanding and memory of theoretical knowledge.

3.3 Continuous Deepening of Students’ Interdisciplinary Cognitive and Professional Comprehensive Competencies

During the implementation of teaching methodologies, emphasis was placed on integrating medical humanities education, professional competency education, and interdisciplinary integration concepts. This approach guided students to establish correct medical ethics and professional values, deepened their understanding of Intelligent Medical Engineering disciplines, and fostered their professional identity and sense of responsibility.

The survey revealed that 93.5% of students gained help students gain a deeper understanding of the "engineering + medicine" integration concept in Intelligent Medical Engineering through course instruction, clarify their professional development direction and enhanced their appreciation for the synergy between medicine and engineering, boosting their interest and motivation in specialized studies (Figure 4A). 78.3% of students believe this course has enhanced their information retrieval skills, while 87.0% and 89.1% report improved oral communication and teamwork abilities (Figure 4B). During student interviews, one participant remarked:

"This course not only equipped me with medical knowledge but also made me realize that the core of Intelligent Medical Engineering lies in applying engineering technologies to serve medicine and human health. This realization has strengthened my resolve to master professional knowledge and contribute to medical advancement."

4. Discussion

This cross-school integrated teaching reform of Introduction to Basic Medicine proves that the full-cycle teaching model with medical-engineering interdisciplinary content reconstruction as the core can comprehensively improve students' autonomous learning ability, medical knowledge reserve and interdisciplinary innovation thinking. By embedding engineering application scenarios into every link of basic medical teaching, the reform realizes the organic combination of theoretical knowledge learning and practical interdisciplinary inquiry, and provides a feasible solution for the teaching dilemma of new cross-school joint training courses without reference experience.

The pre-class-in-class-post-class closed-loop teaching design effectively stimulated students' internal learning motivation. Students complete targeted preview tasks independently before class, take the initiative to put forward interdisciplinary confusion; in the classroom, group inquiry taked students as the main body of knowledge construction, rather than passive recipients of theoretical knowledge; layered post-class tasks match students with different engineering foundations, realizing personalized ability improvement. This student-centered teaching idea is consistent with the inquiry-based learning and active learning theories advocated by modern medical education, and highlights the interdisciplinary characteristics different from single medical major teaching.

However, the reform still has three prominent limitations in the implementation process: The depth of interdisciplinary practical links is insufficient: The current teaching mainly relies on "medical theory + engineering case display", lacking systematic off-campus laboratory practical projects; students' hands-on ability to independently complete medical engineering prototype design needs further improvement; Differentiated layered teaching needs further optimization: A small number of students with weak engineering foundations lack interest in medical theoretical learning, while students with strong engineering foundations think some medical content is too simple; the current layered task design cannot fully meet highly individualized learning demands; The evaluation system needs refined indicators: Although the formative assessment covers pre-class, in-class and post-class links, the scoring standards for innovative thinking and practical design ability are relatively vague; Quantitative measurement indicators for classroom participation and group discussion performance are not detailed enough, which cannot fully reflect students' comprehensive interdisciplinary literacy.

In view of the above deficiencies, four targeted optimization directions are proposed for subsequent curriculum construction: Deepen interdisciplinary practical teaching links: Cooperate with cross-school intelligent medical laboratories to set up serial practical projects including medical signal collection, pathological image AI recognition, and realize the integration of classroom theory and hands-on engineering practice; Optimize personalized layered teaching: Establish student learning baseline files according to pre-course foundation testing, formulate customized preview tasks, homework difficulty and assessment standards for students at different levels, and strengthen one-on-one teacher guidance for students with learning difficulties; Refine the diversified assessment index system: Supplement detailed quantitative scoring rubrics for innovative design and interdisciplinary project reports, increase the weight of practical project evaluation, and build a three-dimensional evaluation system integrating formative process assessment, summative examination and practical project performance.

Long-term follow-up research can further track the thesis quality of the post-reform student cohort to explore the long-term sustained impact of this interdisciplinary teaching model on students' capabilities in innovative research and industrial practice. Meanwhile, this reform framework can be transplanted to other cross-school joint training programs for medical engineering majors to verify its replicability and generalizability.

Declarations

Ethics approval and consent to participate

This study involving human student participants was conducted in strict accordance with the ethical principles outlined in the Declaration of Helsinki (https://www.wma.net/policies-post/wma-declaration-of-helsinki/), and complies with the educational research ethical norms of Harbin Institute of Technology and Harbin Medical University. The research protocol was reviewed and approved by Harbin Medical University Institutional Review Board (Ethics Approval No. HMUIRB2025023PRE). Written informed consent was obtained from all participating students prior to their enrollment in the study. To protect participants' personal privacy, all questionnaire and score data were desensitized and de-identified before analysis. All processed data can only be accessed by authorized members of the research team. All study findings are reported in aggregate form only, and no individually identifiable information is included in this manuscript.

Consent for publication

Not applicable. This manuscript does not contain identifiable individual student data.

Availability of data and materials

The datasets generated and analyzed in this study can be obtained from the corresponding author upon reasonable request.

Competing interests

The authors declare that there are no competing interests.

Funding

This work was supported by Heilongjiang Provincial Higher Education Teaching Reform Research Project [SJGZB2024128].

Authors' contributions

Corresponding author: Overall research conception, teaching reform design, manuscript revision; Weiwei Yang: Curriculum content reconstruction, classroom theoretical teaching, student knowledge assessment; Yan Yan, Fengyan Xu and Yanshuang Wu: Interdisciplinary case development, practical project design, questionnaire data statistical analysis; All authors participated in classroom teaching practice, data collection and sorting, and reviewed and approved the final manuscript.

Acknowledgements

The authors wish to express sincere gratitude to the faculty members and students of Harbin Institute of Technology and Harbin Medical University for their participation and provision of valuable feedback throughout the implementation process of this curriculum reform.

References

1. Ye P, Xu X. (2023). A case study of interdisciplinary thematic learning curriculum to cultivate "4C skills". *Front Psychol*.14:1080811.doi: 10.3389/fpsyg.2023.1080811.
2. Ramya AN, Arya JS, Madhukrishnan M, et al. (2021). Raman Imaging: An Impending Approach Towards Cancer Diagnosis. *Chem Asian J*. 16(5):409-422.doi: 10.1002/asia.202001340.
3. Sriraam N, Chinta B, Suresh S, et al. (2024). Ultrasound imaging based recognition of prenatal anomalies: a systematic clinical engineering review. *Prog Biomed Eng (Bristol)*. 6(2). doi: 10.1088/2516-1091/ad3a4b.

Figure legend

Figure 1. Flowchart of the instructional implementation process for basic medical courses within the Intelligent Medical Engineering major under the context of cross-institutional integration.

Figure 2. The students' learning performance and participation under the full-cycle blended teaching model.

(A) Comparison of pre-class preview completion rate and classroom active participation rate between the first and second cohort of students.
(B) Comparison of average in-class module quiz scores between the first and second cohort of students ($p < 0.001$).
(C) Students' perceived impact of the pre-class preview mechanism on autonomous learning awareness.

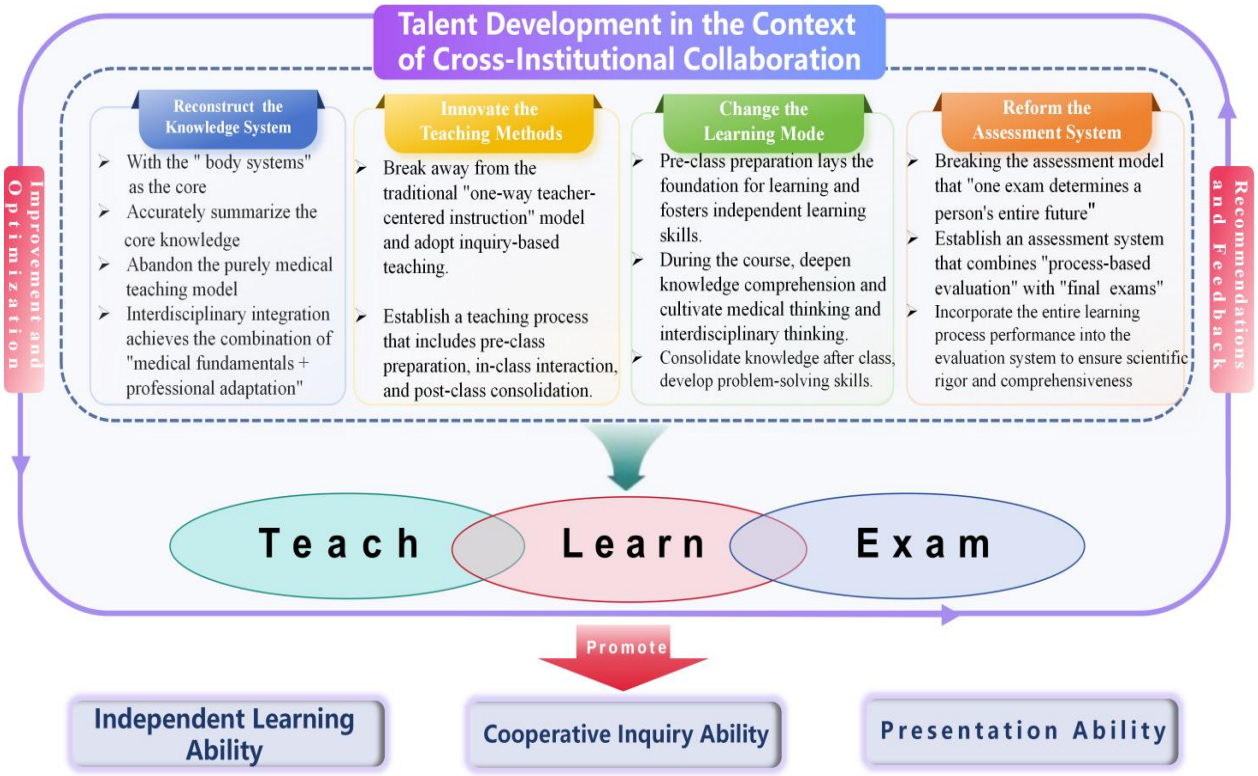
Figure 3. The students' academic performance and teaching satisfaction after teaching reform.

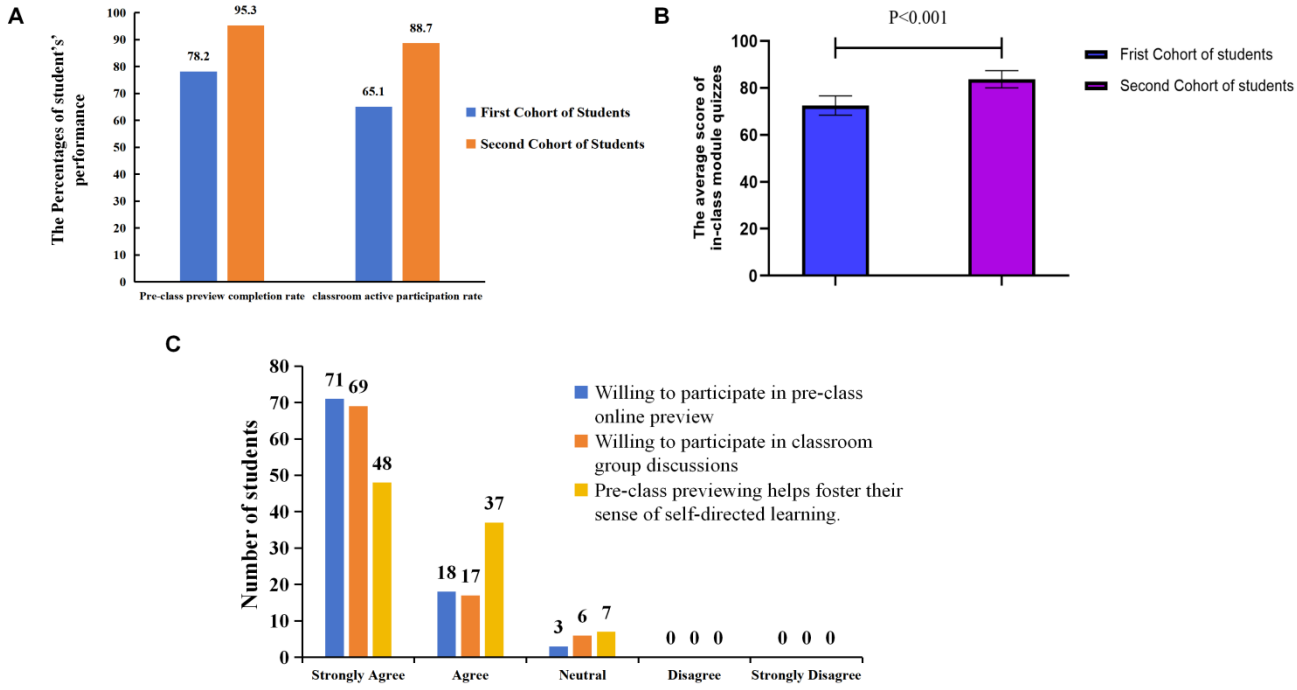
(A) Distribution of students' average total course scores before and after teaching reform.
(B) Comparison of course examination results between two cohorts of students; number of students scoring above 85 points (n=24, 16.3% vs n=34, 27.0%).
(C) Student satisfaction survey results for the integrated medical-engineering teaching reform (n=92).

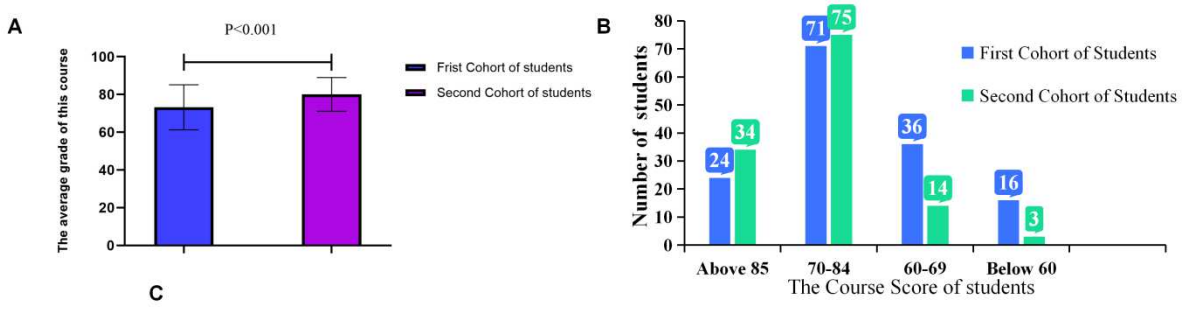
Figure 4. Survey results of students' perceptions of the teaching effect of Intelligent Medical Engineering courses integrating multiple educational concepts

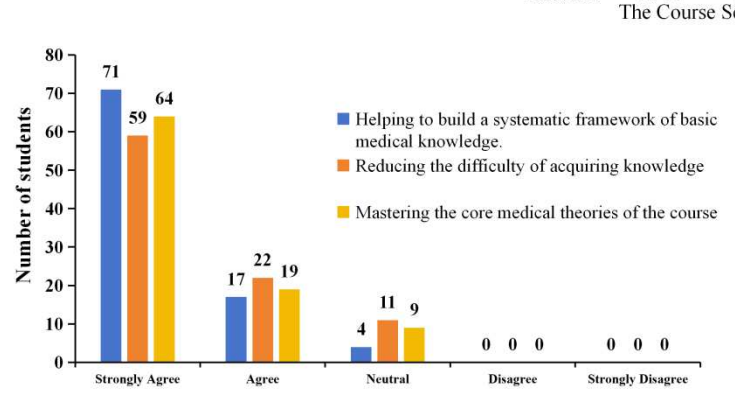
(A) Number of students who deepened their understanding of the "engineering + medicine" integration concept, clarified professional development direction, recognized medicine-engineering synergy, and boosted specialized study interest and motivation through course teaching.

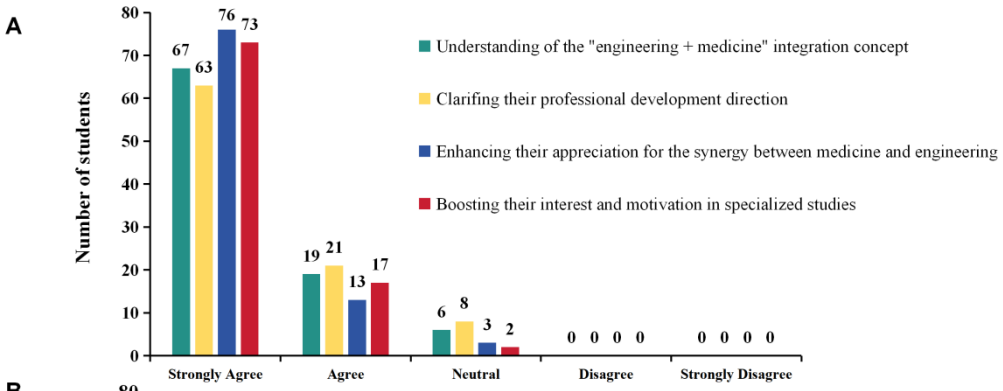
(B) Number of students who reported improved information retrieval ability, oral communication ability, and teamwork ability after taking the course.






A
P<0.001
The average grade of this course
100
80
60
40
20
0
Frist Cohort of students
Second Cohort of students
B
Number of students
80
70
60
50
40
30
20
10
0
24
34
71
75
36
14
16
3
First Cohort of Students
Second Cohort of Students
Above 85
70-84
60-69
Below 60
The Course Score of students


C
Number of students
80
70
60
50
40
30
20
10
0
71
59
64
17
22
19
4
11
9
0 0 0
0 0 0
Helping to build a systematic framework of basic medical knowledge.
Reducing the difficulty of acquiring knowledge
Mastering the core medical theories of the course
Strongly Agree
Agree
Neutral
Disagree
Strongly Disagree


A
Number of students
80
70
60
50
40
30
20
10
0
67
63
76
73
19
21
13
17
6
8
3
2
0 0 0 0
0 0 0 0
Understanding of the "engineering + medicine" integration concept
Clarifing their professional development direction
Enhancing their appreciation for the synergy between medicine and engineering
Boosting their interest and motivation in specialized studies
Strongly Agree
Agree
Neutral
Disagree
Strongly Disagree

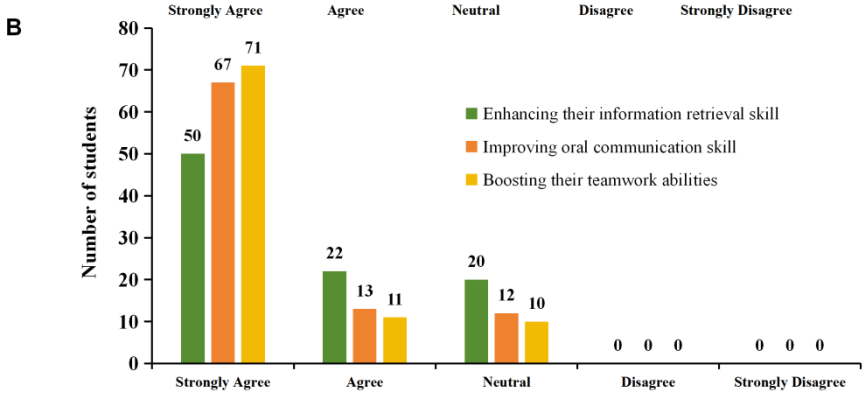

B
Number of students
80
70
60
50
40
30
20
10
0
50
67
71
22
13
11
20
12
10
0 0 0
0 0 0
Enhancing their information retrieval skill
Improving oral communication skill
Boosting their teamwork abilities
Strongly Agree
Agree
Neutral
Disagree
Strongly Disagree

Table 1. "Introduction to Basic Medicine" Course Teaching Feedback Questionnaire

The information of students

Department: _____ Grade: _____

Instructions for filling out: Please, based on the corresponding survey items, mark "√" under the satisfaction level that you consider applicable.

subject of entry		Survey Content	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Students' Multidimensional Learning Engagement and Self-Regulated Learning Ability	1	Willing to participate in pre-class online preview.					
	2	Pre-class previewing helps foster your sense of self-directed learning.					
	3	Willing to participate in classroom group discussions.					
	4	Willing to actively participate in after-class online learning.					
	5	Online learning resources provided after class assist students in reviewing and consolidating what they have learned.					
Evaluation of Curriculum Effectiveness in Basic Medical Education	6	Helping to build a systematic framework of basic medical knowledge.					
	7	Reducing the difficulty of acquiring knowledge.					
	8	Mastering the core medical theories of the course.					
Assessment of Students' Perceptions of the "Engineering + Medicine" Integration and Its Impact on Professional Development	9	Understanding of the "engineering + medicine" integration concept.					
	10	Clarifying your professional development direction.					
	11	Enhancing your appreciation for the synergy between medicine and engineering.					
	12	Boosting your interest and motivation in specialized studies.					
Assessment of General Competency Development	13	Enhancing your information retrieval skill.					
	14	Improving your oral communication skill.					
	15	Boosting your teamwork abilities.					

The following opinion section is optional.

With regard to the course system, do you have any further comments or suggestions?