

and accidents, and provide usage methods and maintenance guidelines for various laboratory equipment to enable students to use the equipment correctly ^[13]. In daily experimental teaching, teachers play an indispensable role: they need to supervise experiments to ensure that students conduct experimental activities in accordance with the relevant provisions of the manual. For any non-compliant behaviors, teachers must stop them immediately and provide critical education, helping students develop a stronger sense of standardization and improve the standardization of their experimental operations.

Students' safety awareness and attitudes are integral to experimental courses, so they should be incorporated into the experimental course assessment system. To this end, we need to develop a scientific and reasonable assessment standard to ensure that the assessment content is comprehensive and fair. The assessment content should not only cover students' mastery of safety knowledge, but also include their safety behavior during experimental operations and their ability to handle emergencies ^[14]. Through this strict assessment method, we can urge students to attach greater importance to laboratory safety, guide them to consciously abide by safety regulations, and thus develop good safety habits. For students who fail the safety assessment, necessary measures will be taken—for example, they will be prohibited from entering the laboratory to conduct experiments until they can prove that they have mastered the necessary safety knowledge and skills and passed the assessment.

3.4. Enhancing teachers' safety literacy

To ensure the safety of teaching and experimental activities in chemistry-related majors, the school regularly organizes professional teachers and laboratory managers to participate in comprehensive safety training. The training covers various aspects, including the latest safety laws, regulations and policies, hazardous chemical management knowledge, experimental safety operation skills, and emergency rescue technologies. To improve training effectiveness, we specially invite safety experts and industry technicians to give lectures ^[15]. Through a variety of teaching methods such as theoretical explanations, practical operation demonstrations, and case studies, we aim to significantly improve teachers' safety knowledge and management capabilities. In addition, we encourage teachers to actively participate in domestic and international safety academic exchange activities, so as to keep abreast of the latest developments in industry safety and continuously update and improve their own safety knowledge system.

In experimental teaching and scientific research activities, we clearly define teachers' safety management responsibilities and incorporate these safety management tasks into teachers' performance appraisal indicators. Before the experiment begins, teachers must make adequate safety preparations, including conducting a thorough inspection of experimental equipment and reagents, and explaining safety precautions to students in detail. During the experiment, teachers need to supervise students' operations throughout the process and promptly identify and eliminate any potential safety hazards. After the experiment, teachers are also responsible for organizing students to clean up the experimental site and properly dispose of waste generated during the experiment. For safety accidents caused by teachers' dereliction of duty, we will investigate and hold them accountable in accordance with laws and regulations, to urge teachers to earnestly fulfill their safety management responsibilities.

4. Conclusion

In summary, to further enhance the effectiveness of cultivating laboratory safety awareness and attitudes among students majoring in chemistry-related disciplines in colleges and universities, we can analyze aspects such as strengthening the construction of safety education courses, creating a safety culture atmosphere, intensifying the

management of experimental teaching, and improving teachers' safety literacy. Through these efforts, the quality of cultivating laboratory safety awareness and attitudes among students majoring in chemistry-related disciplines in colleges and universities can be elevated to a new level.

Funding

Fundamental Research Funds for the Central Universities (Project No.: 842551006)

Disclosure statement

The authors declare no conflict of interest.

References

- [1] Chen Z, Yu J, Wu F, 2025, Discussion on the Standardized Management of Chemical Reagents in University Laboratories. *Chemical Engineering & Equipment*, 2025(3): 150–152.
- [2] Chen X, 2025, Analysis on Safety Emergency Management of University Chemical Laboratories. *Hubei Emergency Management*, 2025(6): 26–28.
- [3] Lü L, Liu J, 2025, Some Explorations on Safety Management of Chemical and Chemical Engineering Laboratories in Universities. *Shandong Chemical Industry*, 54(5): 247–249.
- [4] Zhao F, 2025, Construction of Safety Management System for Hazardous Chemicals in University Laboratories: A Review of Chemical Laboratory Safety Tutorial. *Acta Chimica Sinica*, 83(2): 201.
- [5] Dong X, Shu X, 2025, Reflections on the Survey of Laboratory Safety Education for University Students—Taking the School of Chemistry, Beijing University of Chemical Technology as an Example. *Modern Chemical Research*, 2025(4): 139–141.
- [6] He X, Long X, 2025, Exploration and Construction of Safety Management System for Environmental Chemistry Laboratories in Universities. *Chemical Enterprise Management*, 2025(5): 102–105.
- [7] Wang H, Zhan C, Wang Y, et al., 2025, Bibliometric Analysis of Safety Research on University Chemical Laboratories Based on CiteSpace. *Chemical Enterprise Management*, 2025(5): 88–93.
- [8] Xia Q, Wei N, 2025, Problems and Strategies of Chemical Laboratory Safety Management in Private Universities. *University*, 2025(4): 51–54.
- [9] Wang J, Lu L, Zhang R, et al., 2025, Exploration and Practice of the “Double Prevention and Full Coverage” Mechanism in University Chemical Laboratories. *Research and Exploration in Laboratory*, 44(1): 219–222 + 227.
- [10] Li H, Wei Y, Sun Y, 2025, Construction and Thinking on Safety Management of University Biochemistry Laboratories. *Laboratory Testing*, 3(1): 40–42.
- [11] Cui Z, Song Y, Tang H, et al., 2024, Research and Practice on Safety Management System of University Chemical Laboratories. *Journal of Jilin Engineering Normal University*, 40(8): 59–68.
- [12] Yang D, Geng J, Li H, et al., 2024, Practical Exploration of Safety Education in University Chemical and Chemical Engineering Laboratories. *Research and Exploration in Laboratory*, 43(12): 235–240.
- [13] Yang X, Feng W, Yang X, et al., 2025, Investigation and Analysis of Students' Knowledge, Attitude and Practice on Chemical Laboratory Safety in Universities. *Experimental Technology and Management*, 42(2): 212–219.
- [14] He J, 2024, Current Situation and Countermeasures of Safety Management of Hazardous Chemicals in University

Chemical Laboratories. Sichuan Chemical Industry, 27(6): 44–46 + 55.

- [15] Dai J, Zhang S, Lu X, 2024, Practice and Exploration of Safety Management of Hazardous Chemicals in University Laboratories Under the Green Concept—Taking the Forestry Experiment Center of Inner Mongolia Agricultural University as an Example. Technology Wind, 2024(31): 154–156.

Publisher's note

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

Exploration on the Path of Integrating Curriculum Ideology and Politics into College Physical Education Teaching

Minna Gong*

China Three Gorges University, Yichang 443002, Hubei, China

**Author to whom correspondence should be addressed.*

Copyright: © 2025 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: With the in-depth implementation of educational reform, college physical education should also keep pace with the times and focus on the integration of curriculum ideology and politics to improve the effectiveness and efficiency of talent cultivation. This enables graduates to engage in related work with high professional quality and dedication. To promote the smooth implementation of reform, it is necessary to cultivate students with both moral integrity and academic ability, so that they can better meet social needs. In this process, it is extremely important to face problems squarely and attach importance to the cultivation of students' comprehensive quality. College physical education involves complex teaching content with strong professionalism and practicality, which poses great difficulties for students in learning, understanding and mastering. Therefore, in the process of reform, attention should be paid to the training and improvement of students' comprehensive skills and literacy, and their employability should be continuously enhanced, so as to improve the quality of talent cultivation and education and teaching.

Keywords: Curriculum ideology and politics; College physical education; Teaching path

Online publication: November 3, 2025

1. Introduction

In May 2020, the Ministry of Education issued the Guidelines for the Construction of Curriculum Ideology and Politics in Institutions of Higher Education, which provided a clear direction for the construction of curriculum ideology and politics^[1]. College physical education is a key part of higher education. In addition to imparting sports knowledge and skills, it also undertakes the responsibilities of cultivating students' team spirit, collective sense of honor, patriotic feelings, etc. At the same time, it is also necessary to continuously improve students' physical fitness to lay a solid physical foundation for their study of other courses. Based on this, the integration of curriculum ideology and politics with physical education should focus on values education, effectively integrate it into the teaching of health knowledge, and combine it with sports training, so as to shape students' outlook on the world, life and values, and lay a talent foundation for the construction and development of a sports power^[2].

2. The role of integrating curriculum ideology and politics into college physical education teaching

2.1. Conducive to cultivating students' moral sentiments

An analysis of college physical education reveals that it encompasses two core values, moral cultivation and talent development, and bears distinct ideological and political characteristics. In sports, competition rules not only ensure the smooth conduct of games and uphold fairness and justice, but also serve as an important means to foster students' moral integrity^[3]. These rules not only enable students to clearly and comprehensively understand the norms governing their sports behaviors, but also, by restricting individual conduct, guide them to abide by rules, develop rule awareness, and lay a solid foundation for forming good moral behaviors. Furthermore, the emphasis on fair competition in these rules helps cultivate students' moral consciousness, enabling them to view opponents correctly and show them full respect. Additionally, they play a positive role in nurturing students' sense of integrity and responsibility^[4].

2.2. Conducive to cultivating students' sense of cooperation

Integrating curriculum ideology and politics into college physical education helps cultivate students' sense of cooperation. This integration value is first reflected in the creation of a sports atmosphere: in a relaxed and pleasant environment, students are more willing to communicate sports tactics and share exercise experiences, which is beneficial for developing their collaborative awareness and improving their communication skills^[5]. Secondly, it promotes the spirit of inclusiveness and friendliness, guiding students to try to put themselves in others' shoes when cooperating with others. This is especially important when the competition is not going well—by respecting and understanding teammates, and supporting and encouraging each other, the team's sense of cooperation and cohesion can be enhanced. Moreover, this integration value is also reflected in guiding students to clarify their roles in the team, take the team's goals as the direction of their personal efforts, and while strengthening their team awareness, cultivate their sense of social responsibility and commitment^[6].

3. Difficulties in integrating the concept of “Ideological and Political Education in Courses” into physical education teaching in colleges and universities

3.1. One-sided understanding of the concept of “Ideological and Political Education in Courses”

The effect of integrating ideological and political education into college physical education courses is closely related to teachers' understanding of this concept. At present, some teachers only have a superficial knowledge of the concept itself, and their understanding of its connotation and importance is relatively one-sided, resulting in poor teaching effects. For example, some physical education teachers believe that they only need to teach physical education content and are not responsible for ideological and political education, which they consider to be the duty of ideological and political teachers. Therefore, they do not attach sufficient importance to ideological and political goals when setting teaching objectives. In addition, the way teachers explore and integrate ideological and political elements is single, failing to resonate with students and achieve good educational results. Although some teachers reflect on the effectiveness of their educational efforts, the content of their reflections is insufficient, leading to no significant improvement in their educational capabilities. Their deviated understanding of the concept prevents ideological and political education in courses from exerting its full integration effect^[7].

3.2. Insufficient integration of professional knowledge and ideological and political education

A major difficulty in college physical education teaching is the inability to effectively integrate ideological and political education into physical education professional content, resulting in the two seeming to be integrated but actually operating independently. From a practical perspective, improving the quality of physical education teaching should adhere to the concept of pursuing truth, that is, following corresponding laws such as the law of the formation of motor skills and the law of changes in physiological functions. Ideological and political education in courses, on the other hand, emphasizes the integration of truth, goodness, and beauty to achieve their organic unity^[8]. When integrating ideological and political education into physical education teaching, some teachers focus on skill teaching while neglecting theoretical course teaching, leading to poor completion of teaching tasks. Specifically, they can only achieve the knowledge and skill objectives among the three-dimensional objectives, while ignoring the objectives of emotions, attitudes, and values. The superficial integration of ideological and political education with the teaching of physical education, professional knowledge, and skill training directly affects the shaping of students' outlook on the world, life, and values^[9].

3.3. Inability to quantify the effectiveness of integrating ideological and political education

To promote the high-quality development of physical education, it is necessary to focus on the core, which is to inspire students' souls, and ideological and political education is the concentrated embodiment of this core. At present, the integration of ideological and political education into physical education faces the problem that quantitative evaluation cannot be realized, mainly because ideological and political education and traditional subject teaching differ greatly in essence and objectives. For example, the effectiveness of subject teaching can be measured by exam scores, while ideological and political education mainly assesses non-quantifiable aspects such as students' values and moral qualities. For instance, college physical education teachers mainly use terms such as "patriotic feelings" and "ideological quality" when designing ideological and political objectives. Such teaching objectives cannot be accurately quantified, which adversely affects the effectiveness of their integration^[10].

4. Paths to integrate curriculum ideology and politics into college physical education teaching

4.1. Starting from the concept to improve teachers' cognitive level

The Guidelines for the Construction of Curriculum Ideology and Politics in Institutions of Higher Learning clearly state that the construction of curriculum ideology and politics should be promoted by category according to professional characteristics, and the concept of curriculum ideology and politics should be fully integrated into classroom teaching. The key to integrating curriculum ideology and politics into college physical education teaching lies in the integration of concepts. On the one hand, colleges and universities should attach greater importance, formulate relevant policies based on their own conditions, encourage physical education teachers to conduct in-depth research and practical exploration in this field, promote its effective integration at the institutional level, and facilitate its innovation. On the other hand, colleges and universities should carry out regular training programs and encourage teachers to actively participate, to deepen their understanding of this concept and improve their cognitive level. For example, through training related to curriculum ideology and politics, seminars, and forums, teachers' traditional concepts can be transformed, and their integration ability can

be enhanced^[11].

4.2. Optimizing professional knowledge and ideological and political resources to establish and improve the content system

In the college education system, physical education is an important component. When the sports industry develops vigorously, the professional development of the physical education discipline will be smoother, which is conducive to highlighting the value of physical education courses in resource integration.

Firstly, attention should be paid to improving the ideological and political content of this course, constructing its content system, and focusing on the integration and infiltration of socialist core values. To this end, schools should pay attention to the top-level design of this teaching, promote its internalization and transformation, and integrate its value commonalities and connotations, so as to successfully overcome the difficulties in the integration of the two. In this context, full play should be given to sports functions, such as enabling students to enjoy sports fun and enhance their physical fitness, to advance the integration process. To improve students' personality, universities should effectively integrate ideological and political elements, such as rule awareness and team spirit, making a sound personality an important foundation for their education. Through targeted education and guidance, students' awareness of the rule of law can be cultivated, good habits can be developed, and physical education courses can become a compulsory course for students to cultivate the spirit of abiding by the law and being honest.

Secondly, teachers should embed ideological and political elements into the curriculum objectives when formulating them. The curriculum objective is to guide students to master sports-related knowledge and skills through learning, improve their physical fitness, cultivate patriotic feelings and healthy personalities, and ultimately achieve the fundamental task of fostering virtue through education. When integrating curriculum ideology and politics into physical education teaching, the following points should be noted: it should be implemented throughout the entire teaching process, respect students' subject status, take education as the fundamental goal, deeply explore the educational functions contained therein, and create a new pattern of talent training; the goal of cultivating students' will quality and improving their moral literacy should be organically combined with the goal of curriculum ideology and politics, and through targeted education, students' will quality can be strengthened and their moral behaviors can be elevated, so as to promote students' all-round development and healthy growth through the joint efforts of education; the fundamental task of college physical education teaching is to cultivate qualified builders and successors of socialism, and curriculum objectives should be formulated based on this, demonstrating the discipline's functions, mainly referring to the ideological and political education function.

Thirdly, an in-depth exploration of ideological and political resources in physical education courses should be conducted. To improve the quality of physical education teaching, it is necessary to grasp students' learning situation, follow their growth characteristics and cognitive laws, be bold in innovation, and endow the integration of curriculum ideology and politics with more vitality. For example, in practical teaching, teachers can start from social sports news hotspots, integrate sports events, sports stars, and sports spirits into teaching, which not only attracts students' attention but also improves their learning interest and enthusiasm for participating in classroom teaching, helping them develop correct outlooks on the world, life, and values. For instance, to win a volleyball game, every team member is duty-bound to perform their duties well in their respective positions; only in this way can the team's performance be guaranteed. For example, the receiver should be responsible for passing the ball in place, and the setter should pass the ball well, so that when the ball is passed to the spiker, the offensive

task can be completed. The same applies to other team competitions, which require every team member to have a high sense of responsibility. Such teaching design is conducive to cultivating students' sense of responsibility and dedication. In teaching, teachers guide students to learn various sports skills and tactics, enabling them to break through and surpass themselves, thereby achieving the goal of tempering their willpower.

4.3. Improve the evaluation system and highlight its educational function

First, further clarify the orientation of evaluation, that is, to enable curriculum-based ideological and political education to give full play to its role in shaping students' values, integrate it into physical education teaching, and achieve educational goals. Second, expand the scope of evaluation to include teaching design and process. For example, regarding teaching objectives, specific requirements for curriculum-based ideological and political education should be clarified to promote their organic integration; for the integration into teaching content, it is necessary to deeply explore the ideological and political elements contained therein to enrich its educational connotation; for the integration into teaching methods, students should be inspired to think through questions, especially those related to values, so that students can understand the relationship between physical education and ideological and political education; for the integration into teaching process, students should be encouraged to speak freely and express their opinions, and guided by such values to cultivate students' value identification; for the integration into teaching effects, attention should be paid to students' recognition of the content, understanding of their cognitive level, and analysis of students' performance in class to grasp their values. Finally, evaluation indicators should be continuously adjusted. For instance, various evaluation materials generated during the integration process and teacher-student evaluation content should be used as optimization indicators, so as to demonstrate the educational effect of curriculum-based ideological and political education while improving the educational ability of physical education teachers.

5. Conclusion

In summary, integrating ideological and political education through courses into college physical education conforms to the trend of educational development and the laws of talent growth and success. Therefore, university educators should actively change their concepts to gain a more comprehensive and clear understanding of the concept, connotation, and importance of ideological and political education through courses, so as to actively implement this concept in physical education and strengthen the cultivation of students' core physical education literacy. Starting from the concept, this paper discusses ways to improve teachers' cognitive level, optimize professional knowledge and ideological and political resources, and establish and improve the content system, aiming to improve the quality of college physical education while enhancing the efficiency and effect of talent cultivation.

Funding

2022 General Project of Philosophy and Social Sciences of Hubei Provincial Department of Education, "Research on the Path to Improve Physical Education Teachers' Ability in Curriculum Ideology and Politics under the Background of 'Three-All-Round Education'" (Project No.: 22Y037)

Disclosure statement

The author declares no conflict of interest.

References

- [1] Fei X, Fang L, 2013, *Globalization and Cultural Self-Consciousness: Selected Works of Fei Xiaotong in His Later Years*. Foreign Language Teaching and Research Press, Beijing.
- [2] Hao H, Song S, 2024, Research on the Resource Advantages of Integrating the Spirit of Chinese Sports in the New Era into the Educational Practice of Colleges and Universities. *Contemporary Sports Technology*, 14(10): 129–132.
- [3] Li X, 2021, How Teachers of Ideological and Political Theory Courses in the New Era Master Their “Core Competence”: A Review of Research on the Improvement of Teaching Ability of Teachers of Ideological and Political Theory Courses in the New Era. *Research in Educational Development*, 41(19): 85–87.
- [4] Zhang B, Luo C, Tian Y, et al, 2021, Research on the Path of Integrating Chinese Traditional Culture into the Curriculum Ideology and Politics of Performance Management. *Journal of Hebei North University (Social Science Edition)*, 37(3): 112–114.
- [5] Zhang X, Song G, Hao M, et al, 2020, Research on the Integration of “Curriculum Ideology and Politics” into the Teaching Reform of Biochemistry. *Journal of Hebei North University (Social Science Edition)*, 36(4): 83–85.
- [6] Zheng J, Dong C, Zhu C, 2022, Research on Curriculum Ideology and Politics of Physical Education in Chinese Colleges and Universities: Review and Prospect. *Journal of Shandong Sport University*, 38(4): 67–75.
- [7] Yang X, 2020, Cultivating Soul and Educating People: Research on the Urgency and Own Advantages of the Construction of Curriculum Ideology and Politics in Physical Education. *Journal of Tianjin University of Sport*, 35(1): 13–16.
- [8] Dong C, Fan S, Gao Y, 2021, Theoretical Basis and Structural System Construction for the Establishment of Curriculum Ideology and Politics Elements in Physical Education Major. *Journal of Sports Science*, 28(1): 7–13.
- [9] Wang X, 2019, Several Basic Issues Concerning “Curriculum Ideology and Politics” — Reflections Based on Physical Education “Curriculum Ideology and Politics”. *Journal of Tianjin University of Sport*, 34(3): 188–189.
- [10] Xu W, 2013, *Research on the Theory and Practice of Humanistic Education in College Physical Education*. Beijing Sport University, Beijing.
- [11] Ministry of Education, 2020, Notice on Issuing the “Guidelines for the Construction of Curriculum Ideology and Politics in Institutions of Higher Learning,” visited on August 18, 2021, http://www.moe.gov.cn/srcsite/A08/s7056/202006/t20200603_462437.html.

Publisher’s note

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

Research on the Innovation of AI-Based Blended Teaching Model for Public Computer Courses: Taking University Programming Courses as an Example

Caili Tian, Pan Pu, Wenliang Wu*

College of Information Engineering, Northwest A&F University, Yangling 712100, Shaanxi, China

**Author to whom correspondence should be addressed.*

Copyright: © 2025 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: Public computer courses in universities are compulsory courses for non-computer majors in many colleges and universities. Guided by the “student-centered” teaching philosophy, this study explores in depth the AI-integrated blended teaching model for public computer courses. Taking university programming courses as the specific research object, it integrates the advantages of AI technology and blended teaching to innovate teaching methods and means, and studies the blended teaching model that combines online learning and offline teaching in the teaching of public computer courses. The ultimate goal is to improve teaching quality and cultivate students’ computational thinking, programming ability, and innovative thinking.

Keywords: AI; Online learning; Offline teaching; Blended teaching

Online publication: November 3, 2025

1. Introduction

Artificial Intelligence (AI) has become one of the core technologies of the current era, profoundly influencing people’s ways of working and learning. In the field of higher education, the integration of AI technology has brought new opportunities and challenges to teaching, prompting teachers to explore new teaching models to adapt to the development needs of the times.

Public computer courses are compulsory for non-computer majors in universities. As an important part of public computer courses, university programming courses enable students to master the basic methods of solving problems with computers and acquire the ability to solve practical problems using programming technology. The traditional teaching of this course adopts a “teacher-centered” model, where teachers play a dominant role and teaching is mainly based on lectures. This model has several problems: students lack learning initiative; due to the high difficulty of the course, students have a low utilization rate of after-class learning resources; teachers

cannot answer questions in real time, leading to the accumulation of students' problems and thus undermining their learning confidence.

This study aims to integrate AI into university programming courses to provide diversified teaching support for teachers and bring new learning experiences and methods for students. By combining the advantages of AI technology and blended teaching^[1], it intends to innovate teaching methods, optimize the teaching process, and improve teaching quality.

2. Analysis of the current situation of computer public course education and the application of AI in teaching

2.1. Analysis of the current situation of computer public course education

As an important course for cultivating students' computational thinking and programming skills, university programming courses are in wide demand in the interdisciplinary integration of artificial intelligence, big data, and other fields. The problems existing in current teaching are mainly reflected in three aspects: teaching content, teaching methods, and teaching evaluation. In terms of teaching content, it involves a large number of grammatical rules, algorithm design, and programming concepts. These contents are inherently abstract and complex, making it difficult for students who are exposed to programming for the first time to understand and master. In terms of teaching methods, the teacher-centered lecture model is adopted^[2], where students passively accept knowledge and lack opportunities for active thinking and exploration. In terms of teaching evaluation, emphasis is placed on students' memory and understanding of knowledge, which makes it difficult to flexibly apply the learned knowledge to solve practical problems and comprehensively evaluate students' comprehensive qualities, such as programming ability, practical problem-solving ability, and teamwork ability.

2.2. Analysis of the application of AI in teaching

In recent years, research on the application of AI technology in the field of education has been in full swing. In terms of AI-assisted teaching, AI can provide teachers with diversified teaching support: from organizing teaching content, designing teaching activities, to recommending teaching resources, it helps teachers quickly screen and integrate high-quality teaching resources, saving time and energy on lesson preparation. AI also provides support for students' learning: it offers personalized resource recommendations for students at different levels and with different learning progress, enabling personalized learning. Various intelligent agents can answer students' questions at any time and provide real-time feedback and guidance. When applied to university programming courses, AI provides multiple forms of support in aspects such as teaching content, teaching methods, and teaching evaluation.

3. Design of a blended teaching model combining “Online Learning and Offline Teaching” based on AI

3.1. Design philosophy

Blended teaching and learning is “a learning environment that combines face-to-face teaching with teaching mediated by technology”^[3]. It integrates teachers' in-person instruction with online teaching, emphasizing both the leading role of teachers in guiding, inspiring, and monitoring the teaching process, and fully reflecting the initiative, enthusiasm, and creativity of students as the main body of the learning process. The blended

teaching model emphasizes “student-centeredness”, where students play a dominant role in teaching activities. “Student-centeredness” requires that: the setting of course teaching objectives should be centered on students’ development; the implementation of teaching activities should be centered on students’ learning; and teaching evaluation should be centered on learning effects^[4]. Students’ learning objectives, learning behaviors, and learning assessments are consistent, interact with each other, as shown in **Figure 1**. In the blended teaching model, teachers use AI tools to set teaching objectives for students^[5,6], screen teaching materials, organize students’ learning behaviors, provide feedback on learning activities, and evaluate students’ learning behaviors^[7,8].

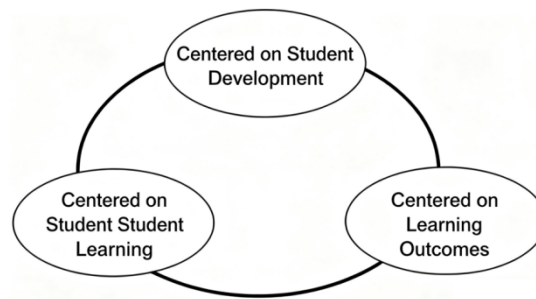


Figure 1. Student-centeredness.

3.2. Construction of teaching model

The AI-based hybrid teaching model for university programming courses can be designed to consist of three complementary modules: the online learning module, the in-class teaching module, and the AI-assisted teaching module.

3.2.1. Online learning module

This module leverages AI to provide students with diverse learning resources and personalized learning experiences. It uses knowledge graphs to organize learning resources, which include course chapter structures, student study guides, knowledge point-related videos, chapter quizzes, assignments, and discussion topics. By constructing relationships between knowledge points through knowledge graphs, the module accurately pushes the most suitable learning resources to each student based on multi-dimensional data such as their learning history, study habits, knowledge mastery, and real-time learning status. Students can independently choose learning content and methods according to their own schedule and learning progress.

3.2.2. In-class teaching module

In the teaching preparation phase, AI tools are used to set teaching objectives, organize and optimize course content, design teaching plans, and enrich teaching cases that integrate programming courses with students’ majors. Teachers can also use AI tools to more efficiently carry out teaching activities such as attendance checking, voting, student selection, quick-response quizzes, topic discussions, tests, and questionnaires. These tools can display the interaction process in real time and intelligently analyze results, thereby stimulating students’ learning interest and improving in-class teaching efficiency.

3.2.3. AI-assisted teaching module

From the student perspective, AI tutors can understand students’ questions and quickly retrieve accurate answers

from a vast knowledge base. In programming courses, this module can not only provide real-time debugging guidance for faulty programs but also generate code on demand, enabling students to solve more complex problems. From the teacher's perspective, it can analyze students' learning behaviors, progress, and knowledge mastery, identify existing problems and potential risks in the learning process, and help teachers adjust teaching strategies and methods in a timely manner. Additionally, it can detect students with academic difficulties in advance and provide early warning information to teachers, facilitating timely intervention measures.

3.3. Design of teaching evaluation system

The university's public computer courses adopt a multi-dimensional evaluation approach, and the course assessment can be divided into two parts: regular assessment and final assessment.

In the regular assessment phase^[9–11], AI tools are used to quantify the assessment of teaching activities. This phase is further divided into three parts: pre-class assessment, in-class assessment, and post-class assessment. The specific evaluation contents and methods are shown in **Table 1**, which are used to measure students' understanding and mastery of the basic knowledge of programming courses.

Table 1. Regular evaluation methods of the course

| Teaching stage | Teaching activities | Evaluation purpose | Evaluation methods |
|----------------|--|--|--|
| Pre-class | 1. Learning task sheet 2. Mind map 3. Knowledge video | 1. Mastery of knowledge objectives 2. Knowledge connection 3. In-class knowledge content | 1. Video view count 2. Unit self-test |
| In-class | 1. Classroom activities 2. Group activities | 1. Students' in-class learning effect 2. Problem feedback and resolution | 1. Classroom activity points 2. Group activity points |
| Post-class | 1. Discussion topics 2. Chapter exam 3. Group assignment | 1. Degree of objective achievement 2. Group collaboration | 1. Discussion topic points 2. Chapter exam 3. Group points |

For the final assessment, students may choose either the examination or the project defense. The examination mainly assesses students' mastery of basic concepts of programming, syntax rules, algorithm design, etc., covering various question types such as fill-in-the-blank questions, short-answer questions, and programming questions. The project defense evaluates students' programming ability and problem-solving abilities. Students are required to design a project that uses application programming to solve problems related to their major, write code with the help of AI tools, independently complete a programming project with certain functions and complexity, and finally obtain the assessment result through the project defense^[12–14]. Through multi-dimensional evaluation and a student-centered approach, diversified assessment for students with different learning levels and abilities is realized.

4. Conclusions and prospects

This study focuses on the research of an AI-based hybrid teaching model for public computer courses. Adhering to the "student-centered" teaching theory, it constructs an innovative teaching model. This model organically integrates online learning modules, classroom teaching modules, and AI-assisted teaching modules, realizing the intelligence and personalization of the teaching process^[15]. In practical teaching, questionnaire surveys show that students have a high satisfaction with the AI-based hybrid teaching model. Their learning interest and enthusiasm

have been significantly improved, and classroom participation and learning activity have been obviously enhanced, indicating that this model can stimulate students' learning enthusiasm and promote their active and autonomous learning. Currently, AI technology is in a stage of rapid development, and its application in teaching still needs to be expanded in terms of depth and breadth. With the advancement of technology, it will be applied to more and more complex teaching scenarios.

Funding

Northwest A&F University Education and Teaching Reform Research Project (Project No.: JY2303099); Shaanxi Province 14th Five-Year Plan for Educational Science Research Project (Project No.: SGH24Q485)

Disclosure statement

The authors declare no conflict of interest.

References

- [1] Tian Y, Xi Y, 2020, Research on the Application of Hybrid Classroom Teaching Mode in Colleges and Universities. *China University Teaching*, (8): 78–96.
- [2] Mao W, Yu Q, 2020, Exploring an English Blended Teaching Model Based on an AI Voice Recognition Platform. *Henan Education: Teacher Education (Lower)*, 2020(3): 3.
- [3] Horn M, Staker H, 2015, *Blended: Using Disruptive Innovation to Improve Schools* (Nie FH, Xu TY, Trans.), China Machine Press, Beijing.
- [4] He K, 2005, New Development of Educational Technology Theory from the Perspective of Blending Learning. *Journal of National Academy of Education Administration*, 2005(9): 37–49.
- [5] Baldwin L, 2018, Editorial: Active Learning in Higher Education. *Active Learning in Higher Education*, 19(2): 95–100.
- [6] Zhang X, Lü L, 2018, Construction of Deep Teaching Mode Oriented to Deep Learning under the SPOC Platform. *China Educational Technology*, 2018(4): 96–101.
- [7] Chen Z, Wang D, et al., 2018, Research and Practice on Hybrid Teaching Mode Based on Knowledge Construction and Interactive Learning. *China University Teaching*, 2018(8): 33–37.
- [8] Ma Y, Lin P, Jin C, et al., 2025, Research on the Innovative Path of “Five Integrations” Hybrid Teaching of Plant Genetics under the Background of New Agricultural Science. *Journal of Smart Agriculture*, 5(8): 150–153.
- [9] Zhang Q, Wang A, 2014, Research on a New Hybrid Teaching Mode Based on “Flipped Classroom”. *Modern Educational Technology*, 24(4): 35–37.
- [10] Zhao Y, Wang S, Li W, et al., 2024, Research on Teaching Reform of Python Programming Courses Empowered by Artificial Intelligence. *Information and Computers*, 36(21): 1–6.
- [11] Wang M, 2018, Exploration of Hybrid Teaching Mode: A Case Study of the New Mode Design for “PS + AI” Course. *Computer Knowledge and Technology (Academic Edition)*, 14(3): 25.
- [12] Huang L, Liao X, 2019, Application of Artificial Intelligence Combined with Blended Teaching in Internal Medicine Education, thesis, *Modern Medicine and Health*.
- [13] Wei SL, Pei Q, Liu L, et al., 2014, Construction and Application of Hybrid Teaching Mode. *Journal of Zhaoqing*

University, 35(2): 77–84.

- [14] Mao W, Yu Q, 2020, Exploration of English Blended Learning Mode Based on AI Speech Recognition Platform. Henan Education: Teacher Education (Part 2), 2020(3): 3.
- [15] Liu H, Lu J, Song H, et al., 2018, Reform and Practice of Hybrid Teaching in Flipped Classroom in the Era of Artificial Intelligence: Taking the Course of “University Computer” as an Example. Science and Technology Innovation Guide, 15(18): 5.

Publisher's note

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

The Promotion of New-Quality Productive Forces Development by Innovation and Entrepreneurship Education in Colleges and Universities

Chenxue Li*

School of Innovation and Entrepreneurship, The University of Shanghai for Science and Technology, Shanghai 200093, China

**Author to whom correspondence should be addressed.*

Copyright: © 2025 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: As the core driving force of innovation-driven development, new-quality productive forces play a crucial role in advancing the development and progress of the modern economy and society. Their construction and development cannot be achieved without the support of new-type top-notch innovative talents. As the main force in cultivating such talents, colleges and universities should attach importance to the organic integration of innovation and entrepreneurship education with new-quality productive forces, to better facilitate the development of new-quality productive forces. Based on this, this paper briefly analyzes the two-way driving effect between innovation and entrepreneurship education in colleges and universities and the development of new-quality productive forces, and expounds the practical paths for colleges and universities' innovation and entrepreneurship education to promote the development of new-quality productive forces. The purpose is to give full play to the promoting role of innovation and entrepreneurship education in the development of new-quality productive forces, hoping to provide some references for peers.

Keywords: Colleges and universities; Innovation and entrepreneurship education; New-quality productive forces; Development; Practical path

Online publication: November 3, 2025

1. Introduction

As an important base for gathering and cultivating innovative talents, colleges and universities should base themselves on the development characteristics and requirements of new-quality productive forces, namely “high technology, high efficiency and high quality,” and actively carry out reforms and innovations in innovation and entrepreneurship education. In this way, they can cultivate and deliver more new-type top-notch innovative talents for the country and society, so as to better promote the development of new-quality productive forces^[1]. Then, in practice, how should colleges and universities give full play to the advantages of innovation and entrepreneurship education to support the construction and development of new-quality productive forces? This

paper mainly focuses on this question and carries out relevant analysis and research, for reference only.

2. Two-way driving between innovation and entrepreneurship education in universities and the development of new-quality productivity

2.1. Innovation and entrepreneurship education in universities is an important foundation for the development of new-quality productivity

On the one hand, innovation and entrepreneurship education in universities functions to aggregate various innovative resources such as knowledge, technology, and talents, which can often provide sufficient support for the development of new-quality productive forces^[2]. Essentially, the formation and development of new-quality productive forces reflect the process of improving the quality of production factors and the efficiency of innovative resource allocation^[3]. In the practice of innovation and entrepreneurship education, universities can cooperate with governments, enterprises, research institutions, and other innovation entities. Through approaches like “conceptual synergy, demand linkage, and co-construction of activities”, they can fully understand the development requirements and market demands of new-quality productive forces. Based on this, universities optimize the content of innovation and entrepreneurship education, strengthen the construction of faculty teams, further realize the exchange, integration, and sharing of resources including knowledge, talents, and technology, and promote the emergence of “new qualities” such as new products, new technologies, and new services, ultimately providing genuine impetus for the development of new-quality productive forces^[4].

On the other hand, the implementation of innovation and entrepreneurship education in universities can provide solid innovative strength support for the construction and development of new-quality productive forces from two aspects: talent innovation and technological innovation^[5]. From the perspective of “talent innovation”, the development of new-quality productive forces has a strong demand for top-notch innovative talents and imposes higher requirements on their capabilities and qualities. Therefore, universities must better meet these talents’ high demands for the speed and breadth of knowledge renewal, and focus more on cultivating their innovative literacy, interdisciplinary capabilities, international vision, cooperation skills, and interdisciplinary competencies^[6]. Under such circumstances, the development of innovation and entrepreneurship education in universities should not be limited to alleviating the issue of “difficult employment” for college students. Instead, it should be guided by the needs of national development strategies. By guiding students to learn innovation and entrepreneurship theories and providing guidance for their innovation and entrepreneurship practices, universities can continuously enhance students’ innovative thinking, innovative spirit, and innovation and entrepreneurship capabilities, thereby providing sufficient talent support for the development of new-quality productive forces. From the perspective of “technological innovation”, according to data released by the National Bureau of Statistics, in 2023, the added value of China’s “three new” economies (centered on new industries, new business forms, and new business models) reached 22.3528 trillion yuan, an increase of 6.4% compared with 2022, accounting for 17.73% of the gross domestic product (GDP), which was 0.37 percentage points higher than in 2022^[7]. It is evident that in China’s current economic transformation process, “new qualities” such as new technologies, new industries, and new businesses have become the “new engine” of China’s economic growth^[8]. By carrying out innovation and entrepreneurship education, universities can greatly improve the transformation rate of scientific and technological achievements, strengthen the supply of original scientific and technological achievements, thereby incubating more innovation and entrepreneurship projects that can adapt to the development of current social and market demands, spawn more emerging industries, provide “gateway” support

for the effective connection between technological innovation and industrial innovation, and ultimately offer sustained technological support and innovative impetus for the development of new-quality productive forces^[9].

2.2. The development of new-quality productive forces can promote the reform of innovation and entrepreneurship education in universities

On the one hand, as a core driving force leading the development of emerging industries and future industries, the development of new-quality productive forces puts forward higher new requirements for the implementation of innovation and entrepreneurship education in universities. Under such circumstances, universities must strengthen the reform of innovation and entrepreneurship education, reconstruct talent training objectives, teaching implementation plans, and curriculum systems, and attach importance to improving the capabilities and qualities of faculty teams. Only in this way can they align with new-quality productive forces and jointly contribute to national and social development.

On the other hand, the social productive forces utilized by people vary across different eras. Consequently, the corresponding talent training objectives of universities will inevitably change, which in turn exerts an impact on educational content, methods, and resources. As a new type of social productive force based on industrial transformation and technological innovation in the new era, new-quality productive forces have a subversive and comprehensive impact on innovation and entrepreneurship education in universities. The development of new-quality productive forces mainly relies on a new generation of scientific and technological means, such as artificial intelligence, big data, cloud computing, and quantum computing, emphasizing the use of various cutting-edge technologies to promote economic and social development and the transformation of modern industries^[10]. Therefore, universities' innovation and entrepreneurship education needs to rely on cutting-edge technologies such as big data and artificial intelligence to strengthen its own innovation, thereby making education more precise and personalized, and further improving the school's school-running model, management system, and guarantee mechanism to better adapt to the development requirements of new-quality productive forces. From this perspective, the development of new-quality productive forces is undoubtedly an important internal driving force for promoting the digital transformation of innovation and entrepreneurship education in universities.

3. Practical paths for university innovation and entrepreneurship education to promote the development of new-quality productivity

3.1. Optimize the allocation of innovation resources and improve the “Coupling Degree” of innovation resources

In the process of carrying out innovation and entrepreneurship education, universities can better stimulate the vitality of innovative industries by strengthening the optimal allocation of innovation resources, which helps to further improve the “coupling degree” of innovation resources, thereby laying a solid foundation for the construction and development of new-quality productivity.

Specifically, universities can start from the following two aspects: On the one hand, considering that innovation and entrepreneurship education is a large systematic project, it cannot be separated from the joint participation of multiple subjects such as the government, social organizations, enterprises, and research institutions^[11]. Based on this, universities must adhere to the principle of “seeking common ground while reserving differences” in the integration of innovation resources for innovation and entrepreneurship education to ensure that educational goals are always “in the same frequency”. In terms of “seeking common ground”,

universities need to fully recognize the common development characteristics of these subjects and build good cooperative relationships based on these commonalities. In terms of “reserving differences”, all subjects should give full play to their respective advantages in education and resources to jointly contribute to the reform of innovation and entrepreneurship education, thereby achieving the goal of promoting the high-quality development of new-quality productivity. For example, universities can provide knowledge and talent resources; enterprises can offer technical and financial support; and the government can provide policy guarantees. In this way, relying on the full cooperation of multiple subjects, the optimal allocation of innovation resource elements can be better realized, resource sharing and complementary advantages can be achieved, and more guarantees can be provided for the cultivation of students’ innovative thinking, interdisciplinary capabilities, and innovation and entrepreneurship capabilities, thus providing more sufficient talent and technical support for the development of new-quality productivity.

On the other hand, universities need to actively build an innovation and entrepreneurship information sharing platform relying on modern technical means, and encourage all subjects to actively share information such as market demand, industry development trends, and industry technological achievements on this platform, to promote the co-construction and sharing of innovation resources, thereby providing more practical innovation and entrepreneurship information and educational resources for “teachers’ teaching” and “students’ learning”^[12]. This can greatly increase the probability of students’ success in innovation and entrepreneurship, enabling them to better contribute their wisdom and strength to the development of new-quality productivity. In this process, universities need to establish a sound supervision mechanism to scientifically supervise and evaluate the innovation resources uploaded by various subjects, to prevent teachers and students from obtaining some low-quality resources that may restrict students’ learning and future development.

3.2. Adhere to the orientation of market demand and improve the “Concentration” of innovative talents

“Talent cultivation” is the foundation and key to promoting the development of new-quality productivity. The formation and development of new-quality productivity cannot be separated from the support and guarantee of talent resources. Although it takes scientific and technological innovation as the engine and industrial transformation as the carrier, these are always inseparable from the direct role of “people”. Therefore, university innovation and entrepreneurship education must adhere to market demand as the basic orientation, focus on issues such as “what kind of people to cultivate, how to cultivate people, and for whom to cultivate people”, and further improve the “concentration” of innovative talents, to deliver more innovative talents for the development of new-quality productivity^[13].

First of all, from the perspective of new-quality productivity, university innovation and entrepreneurship education needs to update teaching concepts in a timely manner, attach importance to the comprehensive cultivation of core qualities of innovative talents such as students’ innovative awareness, innovative spirit, innovation and entrepreneurship capabilities, cooperation capabilities, practical capabilities, management capabilities, digital capabilities, international vision, cross-cultural communication capabilities, and social responsibility, to promote the coordinated development of students’ knowledge, capabilities, and qualities^[14].

Secondly, universities need to strengthen the training of innovation and entrepreneurship teachers, effectively improve the professional level and digital literacy of teachers, and at the same time encourage them to actively integrate advanced cutting-edge technology theoretical knowledge and skill applications into innovation and entrepreneurship education activities, and require them to actively adopt various teaching methods such as

school-enterprise cooperation, blended teaching, project-driven teaching, and innovative practice, so as to better cultivate students into innovative talents needed for the development of new-quality productivity.

Finally, universities also need to increase investment in the construction of digital infrastructure to provide sufficient basic guarantees for the digital transformation of innovation and entrepreneurship education, thereby better ensuring the effect of innovative talent cultivation.

3.3 Emphasize the transformation of technological achievements and increase the “Density” of scientific and technological achievements

Scientific and technological innovation is an important foundation for the development of new productive forces. Therefore, in carrying out innovation and entrepreneurship education, universities need to attach importance to the effective transformation of key core technologies, to continuously improve their original innovation capabilities. This will better promote the implementation and development of new industries, new technologies, and new services, and ultimately, truly empower the rapid development of new productive forces.

On the one hand, universities need to actively guide teachers and students to learn advanced cutting-edge key core technologies, such as autonomous driving, chip research and development, and biomedicine—technologies that are highly compatible with the current industrial structure and can be implemented in the short term. At the same time, they should set up corresponding scientific research projects, research competitions, or organize academic exchange activities, and encourage teachers and students to conduct in-depth exploration and research on new technologies and new industries. This creates favorable conditions for scientific and technological innovation, thereby contributing to the development of new productive forces^[15].

On the other hand, before launching innovation and entrepreneurship education, universities need to conduct in-depth research in industry markets to fully understand the current needs of the industrial sector and future development trends. Based on this, they should encourage teachers and students to develop innovation and entrepreneurship projects, so as to better promote the transformation of educational achievements. After that, universities can also promote these innovations and entrepreneurship projects to the industrial sector through multimedia platforms, thereby transforming scientific research achievements into practical products or services and providing new ideas for the development of new productive forces.

4. Conclusion

In summary, universities play an important role in promoting the development of new productive forces, and the innovation and entrepreneurship education they carry out plays a key role in the construction and development of new productive forces. Specifically, universities can leverage the advantages of innovation and entrepreneurship education to empower the accelerated development of new productive forces through measures such as: optimizing the allocation of innovation resources to improve the “coupling degree” of innovation resources; adhering to market demand orientation to increase the “concentration” of innovative talents; and emphasizing the transformation of technological achievements to enhance the “density” of scientific and technological achievements.

Disclosure statement

The author declares no conflict of interest.

References

- [1] Ma Y, He J, 2025, Practical Dilemmas and Implementation Paths of University Innovation and Entrepreneurship Education Promoting the Development of New-Quality Productive Forces. *China University Students Career Guide*, 2025(2): 98.
- [2] Li J, 2025, Research on the Iterative Upgrade of University Innovation and Entrepreneurship Education from the Perspective of New-Quality Productivity. *Science and Technology & Innovation*, 2025(06): 169–171 + 175.
- [3] Zhan T, 2025, Research on the Training Model of Innovation and Entrepreneurship Ability of University Graduates under the Background of New-Quality Productivity. *Journal of Foshan University (Social Science Edition)*, 43(02): 101–105.
- [4] Gao C, Wu J, 2025, Construction of University Innovation and Entrepreneurship Education System from the Perspective of New-Quality Productivity. *Shanxi Youth*, 2025(01): 46–48.
- [5] Wang X, 2025, Research on School-Enterprise Cooperative Innovation and Entrepreneurship Education from the Perspective of New-Quality Productivity. *The Theory and Practice of Innovation and Entrepreneurship*, 8(01): 196–198.
- [6] Zhuang L, Yao S, 2024, Embedding Model and Practice of University Innovation and Entrepreneurship Education under the Background of New-Quality Productivity. *Education and Teaching Forum (Higher Education Forum)*, 2024(36): 45–49.
- [7] Da Z, 2024, A Brief Discussion on University Innovation and Entrepreneurship Education under New-Quality Productivity. *Career Development and Employment*, 2024(S1): 125–129.
- [8] Wu S, 2024, Mechanism Analysis and Path Research on the Reform of Innovation and Entrepreneurship Education in Higher Vocational Colleges under the Background of New-Quality Productivity. *Journal of Hubei Adult Education Institute*, 30(06): 16–22.
- [9] Zou X, 2024, Research on the Path of New-Quality Productivity Empowering University Innovation and Entrepreneurship Education. *Journal of Qingdao Technical College*, 37(06): 61–65.
- [10] Wang W, 2024, Exploration on the Practical Path of University Innovation and Entrepreneurship Education from the Perspective of New-Quality Productivity. *Development Research*, 41(09): 65–70.
- [11] Duan Z, Zhang Z, 2024, University Innovation and Entrepreneurship Education from the Perspective of New-Quality Productivity: Theoretical Logic, Accurate Positioning and Path Exploration. *Journal of Chongqing College of Electronic Engineering*, 33(04): 115–125.
- [12] Wang H, 2024, Innovation and Entrepreneurship Education: The Fundamental Choice for Universities to Adapt to the Development of New-Quality Productivity. *Jiangsu Higher Education*, 2024(08): 25–33.
- [13] Ma Y, He J, 2024, University Innovation and Entrepreneurship Education Promoting the Development of New-Quality Productivity: Theoretical Logic, Practical Dilemmas and Implementation Paths. *China University Students Career Guide*, 2024(07): 29–38.
- [14] Sun X, 2024, Value Implication and Optimization Path of Innovation and Entrepreneurship Education from the Perspective of New-Quality Productivity. *Fujian Education*, 2024(22): 12–15.
- [15] Jiang C, 2024, Optimization Paths and Practical Exploration of Innovation and Entrepreneurship Education in the Digital Age: A Summary of the Academic Forum on “Innovation and Entrepreneurship Education in the Digital Age.” *Fujian Education*, 2024(22): 7–11.

Publisher's note

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

Analysis on the Application Status of Generative AI Tools in College Physical Education Practical Courses under the Background of Educational Digital Transformation

Xiaolei Li*, Mingxing Liang

Heilongjiang University of Business and Technology, Harbin 150025, Heilongjiang, China

**Author to whom correspondence should be addressed.*

Copyright: © 2025 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: With the deepening of educational reform, college physical education should be further optimized. Teachers need to actively introduce new educational concepts and teaching methods to better arouse college students' interest, improve their understanding and application of the knowledge learned, and enhance teaching effectiveness. As a popular educational auxiliary form currently, generative AI tools can greatly enrich the content of college physical education, expand educational paths, and play an important role in promoting the all-round development of college students. In view of this, this paper will analyze the application of generative AI tools in college physical education practical courses under the background of educational digital transformation and put forward some strategies for reference only.

Keywords: Digitalization; Generative AI tools; College physical education; Application

Online publication: November 3, 2025

1. The application value of generative AI tools in college physical education practical courses in the background of educational digital transformation

1.1. Conducive to enriching teaching resources

Under the background of educational digital transformation, carrying out high-quality college physical education reform enables teachers to introduce more high-quality online resources into the classroom, thereby further expanding educational resources. In the process of education, in addition to using textbooks to carry out educational activities and explain relevant sports knowledge and skills to college students, teachers can also use generative AI tools to introduce some vivid sports events, sports videos and other resources into classroom teaching, so as to bring more novel and interesting sports knowledge content to college students^[1]. In addition, the number of digital physical education resources is extremely large, which can meet the needs of different types of college students. Moreover, the types of online teaching resources are relatively rich, which can lay a solid

foundation for teachers to carry out more in-depth and extensive physical education reform.

1.2. Conducive to expanding teaching paths

In contrast to traditional college physical education, the teaching reform using generative AI tools against the backdrop of educational digital transformation enables teachers to better break down knowledge barriers with college students, allowing students to learn desired knowledge anytime and anywhere. This is of great value for broadening their learning paths. Furthermore, teachers can create a more open and autonomous online learning platform based on college students' physical fitness, knowledge reserves, and cognitive abilities. By integrating generative AI tools, it provides convenience for college students to acquire physical education knowledge, helps them gradually develop good habits of independent exercise, and thereby improves the quality of talent cultivation ^[2].

1.3. Conducive to enriching interaction forms

Essentially, physical education can be regarded as an interactive process between teachers and students based on physical education knowledge. In traditional physical education classes, teachers usually adopt a cramming teaching mode, resulting in insufficient interaction intensity between teachers and students and a single form of interaction, which makes it difficult to highlight college students' dominant position in the classroom ^[3]. Against the backdrop of educational digital transformation, the introduction of generative AI tools can gradually create a more three-dimensional interactive classroom, thereby improving the efficiency of teacher-student interaction, building a more interesting and efficient physical education class, fully stimulating college students' interest in physical education learning, deepening their understanding and application of the knowledge learned, and putting the principle of "teaching students in accordance with their aptitude" into practice.

2. Current situation of physical education teaching in colleges and universities under the background of educational digital transformation

2.1. Insufficient attention

Before the implementation of physical education reform, many teachers regarded physical education as a supplementary course, which made it difficult for college students to attach sufficient importance to physical education and resulted in incomplete teaching plans ^[4]. Over time, college students are prone to form the wrong perception that "physical education courses are unimportant". Influenced by this concept, they can hardly take the initiative to engage in learning physical education knowledge, leading to a sharp decline in their physical fitness ^[5]. In addition, due to the insufficient emphasis on physical education in the examination system, many schools neglect the construction of physical education courses. Physical education teachers are often part-time male teachers from other disciplines. Since these teachers are not graduates of physical education colleges, neither their physical fitness nor their physical education knowledge can meet the learning needs of college students, which is not conducive to the implementation of subsequent physical education reforms.

2.2. Limited teaching staff

At present, many schools do not pay enough attention to physical education, resulting in major deficiencies in the construction of teaching staff. In the process of teaching, some physical education teachers find it difficult to break through the existing teaching models and rarely enrich the content of physical education. Over time,

teachers can hardly feel a sense of accomplishment from physical education teaching, which is not conducive to them realizing their teaching value and leads to the gradual loss of work confidence ^[6]. In addition, the number of physical education teachers in some schools is seriously insufficient. Often, one teacher is responsible for physical education teaching in multiple classes, and there are even cases where one physical education teacher is in charge of the entire grade. This will invisibly impose great work pressure on teachers, which is not conducive to them carrying out reforms and innovations in teaching work, thereby affecting the development of the entire teaching work.

2.3. Inadequate infrastructure

Currently, many schools tend to allocate funds to the development of specialized disciplines, while rarely updating or supplementing the various equipment used in physical education in a timely manner. This leads to inadequate sports facilities in many schools and a lack of proper physical education learning environments for college students, seriously hindering the progress of teachers' efforts to reform physical education teaching ^[7]. In addition, the insufficient introduction of information resources and equipment in some schools is another major factor affecting the efficiency of physical education teaching reform. Although some schools have relatively complete infrastructure construction, teachers fail to master correct teaching management models, and college students struggle to use relevant equipment for training in a reasonable and efficient manner. As a result, some equipment remains idle for a long time, which not only causes a waste of resources but also exerts a negative impact on the effectiveness of physical education teaching reform ^[8].

2.4. Outdated teaching models

Against the backdrop of educational digital transformation, when conducting college physical education, teachers should optimize teaching processes, content, and forms based on students' actual learning conditions to improve teaching effectiveness. However, although some teachers attach importance to teaching reform, there are no signs of reform in actual teaching activities—they still adopt inherent models, which makes it difficult to meet college students' needs for physical education learning ^[9]. Furthermore, in the process of teaching reform, few teachers can optimize existing teaching plans or meet the professional requirements of teachers. This gradually undermines college students' confidence in learning physical education knowledge and is not conducive to fostering their interest in learning. Outdated teaching models will lead to college students' boredom with physical education teaching, trigger various negative emotions, and hinder the improvement of the quality of college physical education teaching reform.

3. Preparations for the application of generative AI tools in college physical education practical courses in the background of educational digital transformation

Under the background of educational digital transformation, the reform of college physical education is still in its initial stage, and many preparations are not yet complete. Therefore, before applying generative AI tools to physical education courses, teachers should make preliminary preparations based on specific student learning conditions to ensure the effect of practical teaching reform and improve the quality of talent cultivation ^[10].

Under the background of educational digital transformation, when applying generative AI tools, teachers should try to integrate physical education teaching with generative AI tools. In addition to reflecting innovations in teaching equipment, they should also optimize their teaching concepts and teaching methods ^[11]. To this

end, if universities want to improve the application effect of generative AI tools, they need to establish a highly professional and capable information-based physical education teaching team based on actual conditions. They should further expand the current teaching content and teaching forms in light of college students' actual learning needs, laying a solid foundation for subsequent teaching reforms.

Under the background of educational digital transformation, when implementing the application of generative AI tools, teachers should build a generative AI tool application resource library with extremely rich content and strong pertinence according to actual needs. In this resource library, teachers can integrate videos, online documents, micro-courses, etc., used in daily teaching, and then classify and organize them to meet the application needs of generative AI tools in the background of educational digital transformation. By enriching online resources, the efficiency of teachers' application of generative AI tools in physical education teaching will be further improved, and college students can also obtain more references in their learning, which is of great significance to improving teaching quality^[12].

4. Application strategies of generative AI tools in college physical education practical courses under the background of educational digital transformation

4.1. Leveraging online AI videos to stimulate college students' interest

In the process of college physical education reform, the importance of interest cannot be overstated, as it is regarded as a key prerequisite for teachers to successfully apply generative AI tools in the background of educational digital transformation. If teachers fail to adopt appropriate methods to stimulate college students' interest during the implementation of physical education reform, it will be difficult for students to experience the true value of generative AI tools, thereby negatively impacting the application effects of these tools^[13]. Therefore, teachers should consider introducing generative AI tools to carefully select sports-related video content from online resources for college students, such as Olympic event videos and sports skill teaching videos. This can more effectively stimulate students' audio-visual perception, promote their multi-dimensional understanding and analysis of the sports knowledge they have learned, and further arouse their curiosity, laying a solid foundation for subsequent physical education reform. Before selecting video content, teachers should conduct an in-depth analysis of college students' sports knowledge level, cognitive ability, and interest preferences, and based on this, select sports videos that are more in line with students' needs to effectively stimulate their interest.

4.2. Integrating micro-courses to deepen college students' understanding

Some college students have limitations in their comprehension ability. If physical education is solely based on textbook content, students may struggle to grasp the core and difficulties of the knowledge, which will affect their practical ability in subsequent sports training and further impact the effectiveness of sports learning. In the traditional college physical education teaching model, teachers usually adopt the method of "theoretical explanation plus demonstration and training": first guiding students to learn sports theories in class, then conducting practical training on the playground. During the demonstration and training session, teachers demonstrate once and then ask students to imitate. Although this method can achieve teaching objectives to a certain extent, it is often insufficient to help students deeply understand the connotation of sports knowledge and sports skills, and may also lead to unnecessary consumption of students' physical strength and energy^[14].

In view of the current trend of educational digital transformation, integrating generative AI tools into physical education classes has become a new attempt. By combining micro-course teaching, teachers are

expected to break through the key and difficult points in physical education and deepen students' understanding of sports knowledge. When designing micro-courses, the duration should be strictly controlled to 5 to 10 minutes, and the interest of micro-courses should be continuously improved to enhance their appeal to college students and ensure their teaching value. Promoting physical education reform through micro-courses can more effectively attract students to participate in the exploration and practice of sports knowledge, help them understand the learned content more deeply, and thus improve the efficiency of sports learning.

4.3. Building an online platform and improving the knowledge system

Against the backdrop of educational digital transformation, to enhance the application effectiveness of generative AI tools, teachers must attach importance to cultivating college students' autonomous learning capabilities. Guiding college students to develop good self-learning habits helps them gradually form sound exercise habits, which is of great significance for improving their physical fitness. However, in traditional physical education practice, college students rarely engage in high-quality autonomous physical education learning. The main reason for this is the lack of an appropriate online self-learning platform, making it difficult for them to solve problems promptly. This not only affects the efficiency of their autonomous learning of physical education knowledge but also may hurt their learning mindset, which is not conducive to improving their physical education knowledge system. To address this issue, teachers can build an online platform integrated with generative AI tools based on the actual situation of their university. When college students encounter obstacles in self-learning physical education knowledge, they can upload their questions to the platform and solve them with the help of classmates and teachers, thereby smoothly advancing subsequent self-learning activities ^[15]. In addition, in the process of applying generative AI tools, teachers can also develop an after-class assignment function on the online platform and regularly release physical training programs. After completing the physical training, college students can submit their training results, reflections, and related questions, which will serve as an important basis for teachers to conduct targeted evaluations.

4.4. Conducting reasonable evaluations and improving teaching issues

In advancing the reform of college physical education, teachers should emphasize the importance of teaching evaluation. Implementing a reasonable and scientific evaluation system helps college students identify their shortcomings in physical education learning, thereby supplementing and improving relevant knowledge points. Based on the evaluation results, teachers can optimize and innovate the content and form of subsequent physical education teaching reforms, effectively solving potential problems and improving the quality of education. Before conducting teaching evaluations, teachers should consider the physical characteristics and knowledge levels of different college students and implement a hierarchical evaluation to ensure the pertinence and effectiveness of physical education teaching. For college students with weak physical fitness, evaluations should focus on theoretical knowledge and encourage them to learn health maintenance knowledge independently to enhance their physical fitness. For average college students, evaluations should cover both theoretical knowledge and sports skills, ensuring that they master the basics while also proficiently acquiring fundamental sports skills and maintaining sufficient exercise volume to meet the needs of physical development. For college students with excellent physical fitness, while evaluating their physical education theoretical knowledge, higher requirements should be put forward to motivate them to continuously challenge themselves and improve their comprehensive abilities.

5. Conclusion

In summary, to enhance the application effect of generative AI tools in college physical education practical courses against the backdrop of educational digital transformation, teachers can start from the following aspects: leveraging online videos to arouse college students' interest; combining micro-courses to deepen their understanding; building online platforms to improve knowledge systems; and conducting reasonable evaluations to address teaching problems. By doing so, the application quality of generative AI tools in college physical education practical courses under the context of educational digital transformation will be invisibly elevated to a new level.

Disclosure statement

The authors declare no conflict of interest.

References

- [1] He L, Wang Y, He J, 2025, Research on the Construction of Digital Teaching Competence Model for College Physical Education Teachers. *Modern Business Trade Industry*, 2025(11): 42–44.
- [2] Wang X, Chen M, 2025, Innovation of College Physical Education Teaching Reform Model Driven by Digital Empowerment. *Science & Technology of Stationery & Sporting Goods*, 2025(08): 119–122.
- [3] Liang C, 2025, Research on the Value, Dilemmas and Countermeasures of Digital Transformation of College Physical Education. *Contemporary Sports Technology*, 15(11): 58–61.
- [4] Chen L, 2025, Research on the Innovative Practice Path of College Physical Education under the Digital Background. *Heilongjiang Daily*, April 10, 2025.
- [5] Lu X, 2025, Research on the Problems and Paths of Physical Education under the Background of Educational Digitalization. *Science & Technology of Stationery & Sporting Goods*, 2025(07): 95–98.
- [6] Wang R, 2025, Practical Path of Digital Empowerment for Ideological and Political Education in College Physical Education Courses. *Heilongjiang Daily*, March 26, 2025.
- [7] Li G, 2025, Research on the Application of Digital Tools in College Physical Education—Taking Artificial Intelligence as an Example. *Bulletin of Sport Science & Technology*, 33(03): 276–278.
- [8] Yang Z, 2025, The Path to Construct the Process Evaluation System of College Sports Based on the Digital Age. *Frontiers in Sport Research*, 7(1): 15–21.
- [9] Li Y, Wang C, 2025, Research on the Path of Digital Construction of College Physical Education. *Henan Education (Higher Education Edition)*, 2025(02): 65–67.
- [10] Huang L, Feng W, Rao Y, 2025, Investigation on the Current Situation and Promotion Path of Digital Literacy of Physical Education Teachers in Colleges and Universities in Henan Province. *Contemporary Sports Technology*, 15(05): 130–134.
- [11] Li R, Song S, 2025, New Opportunities, New Dilemmas and New Directions of Digital Transformation of College Physical Education under the Background of Educational Power. *Science & Technology of Stationery & Sporting Goods*, 2025(03): 97–99.
- [12] Pan W, Yu Y, Wu M, et al., 2025, Current Situation and Countermeasures of Digital Construction and Application of Physical Education Courses in Colleges and Universities. *Management Engineer*, 30(01): 65–69.
- [13] Chen M, 2025, Research on the Development of Digital Literacy of College Physical Education Teachers under the

Background of Educational Digitalization. *Contemporary Sports Technology*, 15(04): 117–120 + 124.

- [14] Zheng L, 2025, Research on the Construction and Application of Digital Curriculum System of College Physical Education from the Perspective of Core Literacy. *Journal of Tianjin Vocational Institutes*, 27(01): 51–55.
- [15] Guo T, 2025, Discussion on Digital Empowerment for High-Quality Development of College Physical Education. *Proceedings of the Academic Symposium on Innovative Development of Intelligent Teaching (Intelligent Education Special Topic)*, Haikou University of Economics - Wulinfeng School of Physical Education: 69–72.

Publisher's note

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

Research on Innovation and Practice of Higher Vocational English Teaching Based on the Integration of Industry and Education

Chunhua Lu, Yanhong Bao, Xia Li

Siping Professional College, Siping 136000, Jilin, China

Copyright: © 2025 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: With the acceleration of globalization, China's industries have begun to undergo transformation and innovation, and cultivating high-quality, high-level compound talents has become the core task of vocational education. As an important part of the higher vocational education system, English plays a vital role in talent cultivation. The widespread application of the "integration of industry and education" teaching model has pointed out the direction for the innovation and reform of higher vocational English teaching. Based on this teaching model, this paper explores the paths of innovation and practice in higher vocational English teaching, which not only improves teaching quality but also is of great significance for cultivating international talents who can adapt to the development of industries and the needs of the new era.

Keywords: Higher vocational English; Integration of industry and education; Teaching model; Innovation; Teaching reform; Talents

Online publication: November 3, 2025

1. Introduction

The National Vocational Education Reform Implementation Plan emphasizes the importance of the integration of industry and education, which has been identified as a key direction for vocational education reform and high-quality development. With the rapid development of social economy and the acceleration of globalization, the goal of talent cultivation in vocational education has gradually shifted from single professional skill training to cultivating high-quality compound talents. English is an important language tool for higher vocational students to enhance their workplace competitiveness and achieve sustainable development. However, at present, the English teaching system in higher vocational colleges is disconnected from the current enterprise development and employment needs, and there exists a problem that the curriculum teaching model is difficult to adapt to market demands. The "integration of industry and education" teaching model emphasizes the organic integration of vocational colleges and enterprises to realize the joint cultivation of talents. Under this model, teachers can integrate enterprise needs and English post standards into classroom teaching, and cultivate students' English

skills, English application ability and intercultural communication ability through diversified English teaching practices.

2. Problems in higher vocational English teaching under the integration of industry and education

2.1. Imbalance between theoretical teaching and practical teaching

At present, English courses in many higher vocational colleges focus too much on the teaching of theoretical knowledge, only teaching listening, speaking, reading, writing, and other contents, and only learning materials from textbooks, which falls into the category of theoretical education. There is a lack of integration of real enterprise elements into teaching, and no training or practical sessions tailored to the enterprises where students will work in the future. This leads to a situation where, although students have a good grasp of English grammar and a large vocabulary, they are unable to use English to complete job tasks related to their majors after entering enterprises. They struggle to write professional documents in English in the workplace and have difficulty communicating effectively with international partners at international conferences. Such higher vocational education that fails to adapt to workplace needs has inadvertently caused the disconnection between theory and practice, which is not conducive to the development of enterprise talents nor the progress of higher vocational education ^[1].

2.2. Disconnection between the teaching system and market demand

The main problem in current higher vocational English teaching is that the teaching content is divorced from practical requirements, which is mainly reflected in outdated and impractical curriculum content, overly single teaching methods, unreasonable evaluation methods, and the lack of a relatively complete mode and mechanism for the integration of industry and education ^[2]. Specifically in practice, English courses in higher vocational colleges are textbook-centered, focusing on imparting traditional language knowledge such as grammar, vocabulary, and reading, while ignoring the combination with the actual application in industries and enterprises; The teaching method in class is still the teacher-centered lecture style, resulting in extremely low student participation, failure to arouse students' learning interest and give full play to their initiative, and inability to effectively cultivate students' language practical ability and creative thinking; Evaluation focuses too much on the final exam, ignoring attention to students' learning process and practical ability. The evaluation results lack comprehensiveness and objectivity, which cannot accurately reflect students' learning effects and real levels, and affect their all-around development.

2.3. Imperfect establishment of the teaching system

As an important way to evaluate students' learning achievements and teachers' teaching effects, teaching evaluation mainly conducts a comprehensive and multi-angle evaluation of teaching objectives, teaching process, teaching achievements, and teaching methods ^[3]. Educational evaluation is an indispensable link in the educational process. It can not only objectively reflect students' learning status, but also provide valuable feedback for teachers' teaching, thereby promoting the continuous improvement of teaching quality. However, from the current English teaching system in higher vocational colleges, there is still the problem of an imperfect teaching evaluation system. First of all, the evaluation process pays too much attention to the results of students' learning, while ignoring their progress and efforts at various stages. This one-sided, result-oriented

evaluation method cannot fully reflect students' learning process and efforts. Secondly, the content of the English educational evaluation system is relatively limited, only focusing on students' assessment scores and homework completion. It not only ignores the evaluation of students' performance, attitude, comprehensive English ability and other aspects in the learning process, but also neglects the comprehensive evaluation of professional quality, innovative ability and so on.

3. Innovation and practical paths of higher vocational English teaching based on the integration of industry and education

3.1. Optimizing the English teaching system and implementing the integration of industry and education

From the perspective of industry-education integration, higher vocational colleges need to deeply explore the practicality of English and its representative characteristics in various positions based on English's own advantages and features. They should strengthen the adaptation of English teaching to enterprise positions, design interdisciplinary talent training programs, and emphasize the market orientation and professionalism of English teaching, so as to implement the integration of industry and education and promote the high-quality development of higher vocational English teaching^[4].

First of all, higher vocational colleges need to conduct comprehensive and systematic surveys on the market orientation of English regularly, maintain extensive contacts with relevant enterprises, and gain an in-depth understanding of enterprises' development directions and new job demands. They should analyze the current market and enterprises' requirements and standards for English talents, and communicate with enterprise professionals in English-related fields to learn about the capabilities and qualities that English talents should possess, which will serve as an important reference for English course teaching^[5]. A more comprehensive grasp of market information and English talent standards can help teachers design teaching plans more systematically and carry out targeted English teaching activities. Understanding the market orientation of English can make higher vocational English teaching more in line with the actual needs of industry-education integration, thereby further improving teaching quality.

Secondly, under the industry-education integration model, higher vocational colleges can design a "vocational orientation + modular" curriculum system, dividing English courses into basic modules and vocational modules^[6]. In the basic module, teachers can mainly impart basic English knowledge and skills to students, including grammar, vocabulary accumulation, writing, listening, reading, and English expression skills, laying a solid foundation for subsequent learning. In the vocational module, teachers need to collect and integrate high-quality teaching resources based on industry development trends, international English talent standards, and students' career plans, integrate them into teaching content, and take students' career development as the core goal to cultivate their English proficiency and intercultural competence.

Finally, teaching content is a necessary factor for promoting the innovation of higher vocational English teaching and a key support for realizing the integration of industry and education. To improve students' English application ability, professional competitiveness, and vocational literacy, higher vocational English teachers need to optimize teaching content and make it closely linked to the demands of English-related positions^[7]. Specifically, teachers can update teaching content in a targeted manner according to enterprise needs, and introduce the latest industry trends, English workplace cases and English projects to keep teaching content consistent with the demands for English talents. At the same time, teachers can also create situational teaching

based on real English projects, allowing students to simulate the application of English in the workplace according to project requirements, thereby strengthening their professional knowledge and improving their application ability.

3.2. Building a teacher team and improving teachers' English proficiency

From the perspective of industry-education integration, teachers need to continuously improve their capabilities through professional learning and practical teaching to meet the needs of the times. Higher vocational colleges should strengthen the development of their teaching teams to build a high-level English teaching team.

First, teachers need to enhance their understanding and implementation of the national industry-education integration policies, and grasp the relevant policy orientations and reform measures, so as to gain a deep understanding and recognition of industry-education integration. At the same time, higher vocational colleges can formulate teacher training plans and regularly send teachers to cooperative enterprises for on-the-job internships, temporary postings, or project research and development. This not only helps teachers understand the actual needs and technological trends of enterprises, master the key points and core of English teaching, and clarify the direction of English talent cultivation, but also enhances their teaching practice ability and English application ability, thereby further enriching their practical experience^[8].

Second, higher vocational colleges can establish in-depth cooperative relationships with outstanding foreign-funded enterprises, and invite experienced enterprise experts or foreign teachers to the campus to conduct training, providing in-service teachers with practical guidance, special lectures, or case studies. This helps improve teachers' professional English competence, enrich their practical experience, and enhance their English proficiency.

Finally, teachers need to improve their scientific research capabilities and strengthen the connection between scientific research and industry. Encouraging teachers to cooperate with industries in developing scientific research projects can not only stimulate the motivation for school-enterprise cooperation but also promote the implementation and transformation of more scientific and technological achievements, thereby expanding the development space for industry-education integration in higher vocational education^[9].

3.3. Strengthen students' oral English training and enhance teaching effectiveness

With the accelerating process of globalization, the role of English in enterprise development has become increasingly prominent. Proficiency in spoken English has become an important criterion for contemporary enterprises to evaluate talent. Meanwhile, oral English proficiency is a key tool for students to improve themselves, broaden their horizons, and enhance their workplace competitiveness, as well as a booster for achieving international development^[10]. Under the mode of industry-education integration, teachers need to take improving students' oral English ability as a key goal. Higher vocational English teaching should strengthen oral English instruction, take textbook content as the foundation, and train students' workplace oral English skills to enable them to better play their roles in the future workplace. Specifically, modern enterprises have high requirements for employees' oral English ability, which is also their basic standard for English-speaking talents. In higher vocational English teaching, due to the differences in students' oral English proficiency, English teachers need to implement the teaching principle of proceeding in an orderly way and step by step—from the pronunciation of English words to short oral English exercises, and then to impromptu speeches without scripts—to strengthen students' oral English ability^[11]. At the same time, English teachers need to introduce some representative oral English cases into classroom teaching, allowing students to practice oral English according

to scenarios, themes, and character roles, so as to promote their in-depth understanding of workplace English. In oral training, English teachers need to provide careful guidance on students' pronunciation and grammar usage, thereby helping students develop relatively authentic oral English.

In addition, English teachers can create oral English practice scenarios by introducing various English-related cases from enterprise operations into classroom teaching, and then guide students to conduct oral training according to specific processes^[12]. For example, combined with textbook content, English teachers can introduce enterprise projects related to "overseas business connection", guide students to conduct comprehensive management and analysis of the project, identify the English skills required, and help students strengthen these skills in a targeted manner. Then, students can conduct drills in groups, with teachers providing on-site guidance. Through a series of learning interactions and guidance, students can gradually master professional English skills.

3.4. Utilizing modern information technology to build intelligent learning channels

Against the backdrop of the new era, information technology is developing rapidly and has been widely applied in the field of vocational education. Traditional teaching methods can hardly meet society's demand for English talents. To better align with the teaching philosophy of integration of industry and education, higher vocational colleges need to actively promote teaching reforms, introduce modern information technology into classroom teaching, and create a more diversified and three-dimensional teaching environment. This will help better cultivate students' English proficiency and enable them to adapt to the changing trends of the new era^[13]. First, higher vocational colleges should leverage information technology to introduce diverse teaching formats. For example, they can offer online courses, build virtual training labs, develop English learning platforms for students, and establish digital resource databases, thereby creating a convenient and efficient learning channel for students.

Second, colleges can build smart classrooms with the help of technologies such as big data and artificial intelligence (AI), which include AI robots, virtual software, electronic whiteboards, intelligent projectors, and VR/AR equipment. These facilities enable intelligent management of the teaching process as well as intelligent evaluation and feedback, thereby improving teaching effectiveness. In addition, AI technology not only supports teachers in English education and research but also injects new vitality into the practical teaching of English courses in higher vocational colleges by virtue of its powerful functions^[14], better cultivating students' ability to use English in real work scenarios and enabling them to be more confident and outstanding in their future careers.

3.5. Improving the teaching evaluation system to promote students' all-round development

From the perspective of the integration of industry and education, a sound teaching evaluation system needs to reflect the tenet of aligning with enterprise needs, to better cultivate students' professional capabilities and their ability to analyze and solve practical problems. The evaluation process is not limited to the assessment of students' learning outcomes by teachers and enterprise tutors, but also includes peer evaluation among students, as well as evaluation of teachers by enterprises, schools, and students. The evaluation content focuses on assessing students' comprehensive quality and professional literacy, and the evaluation standards need to be jointly formulated by teachers and enterprise tutors^[15]. Peer evaluation among students can cultivate their sense of teamwork and cooperation spirit, and improve their self-awareness, learning ability, and reflective ability. For teacher evaluation, elements such as student feedback, teaching objective setting, course teaching task design, understanding of the integration of industry and education philosophy, and research achievements in the integration of industry and education can be incorporated, thereby encouraging teachers to continuously improve

their teaching skills and strengthen in-depth cooperation with enterprises.

At the same time, teachers should focus on the comprehensiveness of evaluation content. In the traditional evaluation system, teachers only evaluated students' learning outcomes while ignoring the assessment of their mastery of various abilities, which led to students' unbalanced development and thus affected their future employment. Therefore, teachers should improve the evaluation system and focus on assessing students' knowledge mastery, skill level, and professional literacy to promote their all-around development.

Disclosure statement

The authors declare no conflict of interest.

References

- [1] Huang Y, 2025, Exploration on the Cultivation of English Major Talents in Higher Vocational Colleges from the Perspective of Industry-Education Integration. *Learning Weekly*, 2025(16): 65–68.
- [2] She J, 2025, Paths of Industry-Education Integration Reform in Higher Vocational English Teaching under the Internet Background. *Teacher*, 2025(09): 83–85.
- [3] Fu Y, 2025, Research on the Design and Implementation of English Education Courses under the Background of Industry-Education Integration. *Overseas English*, 2025(06): 217–219 + 231.
- [4] Li Q, 2025, Research on the Innovation of Higher Vocational English Teaching Mode from the Perspective of Industry-Education Integration. *Journal of Puyang Vocational and Technical College*, 38(02): 46–48 + 53.
- [5] Wang H, Zhou J, Deng J, 2025, Research on Talent Cultivation of “Industry-Education Integration and School-Enterprise Cooperation” in Higher Vocational English. *Industrial & Science Tribune*, 24(06): 126–128.
- [6] Wang L, Yang X, 2025, Exploration on the Teaching Mode of Business Oral English in Colleges from the Perspective of Industry-Education Integration. *The Guide of Science & Education*, 2025(07): 33–35.
- [7] Liu X, 2025, Research on the Path of Ship English Teaching Reform under the Background of Industry-Education Integration. *Journal of Liaoning Higher Vocational*, 27(02): 57–60 + 103.
- [8] Chen Y, 2025, Research on the Innovation of English Course Teaching Mode for New Energy Vehicle Major under the Background of Industry-Education Integration. *Journal of Hubei Open Vocational College*, 38(03): 13–15.
- [9] Zhuang J, 2025, Innovative Strategies of Higher Vocational English Teaching under the Background of Industry-Education Integration. *Life & Partner*, 2025(02): 82–84.
- [10] Su Y, 2024, Research on Industry-Education Integration Helping the Cultivation of Core Competencies of Cross-Border E-Commerce English Talents. *International Public Relations*, 2024(24): 173–175.
- [11] Wang L, 2024, Analysis on the Professional Development Path of Public English Teachers in Local Higher Vocational Colleges under the Background of Industry-Education Integration. *Journal of Tongling Vocational and Technical College*, 23(04): 1–4 + 33.
- [12] Duan C, 2024, Analysis on the Path of Industry-Education Integration Reform in Higher Vocational English Teaching. *Hebei Economic Daily*, 2024(10): 76–83.
- [13] Chen L, Hu LJ, 2024, Research on the Talent Cultivation Path of English Majors in Higher Vocational Colleges under the Background of Industry-Education Integration. *English Teacher*, 24(22): 62–64.
- [14] Jiang H, 2024, Research on the Cultivation of College English Teachers' Information Literacy from the Perspective of Industry-Education Integration. *China Journal of Multimedia & Network Teaching (Upper Issue)*, 2024(11):

102–105.

- [15] Wang J, 2024, The Reform and Innovation Path of College English Teaching under the Background of Industry-Education Integration. *Modern English*, 2024(21): 60–62.

Publisher's note

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

Exploration and Practice of Online and Offline Blended Teaching Mode of Circuit Foundation

Han Wu*, Wei Yang, Guangming Li

School of Physics and Electrical Engineering, Liupanshui Normal University, Liupanshui 553004, Guizhou, China

**Author to whom correspondence should be addressed.*

Copyright: © 2025 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: As a basic course in electrical specialty, Circuit Foundation has strong theoretical and professional characteristics. It is difficult for students to learn. Traditional teaching methods are mostly centered on textbooks and theoretical teaching, which is not conducive to the understanding and flexible use of knowledge points. It cannot promote the cultivation of students' innovative ability. The online and offline teaching modes have changed the traditional classroom teaching mode, which can fully mobilize students' learning enthusiasm and creativity. Enhance students' interest in learning. In this paper, taking the course of "Circuit Foundation" as an example, the online and offline hybrid teaching mode is constructed, and the teaching design is carried out. The practice results show that the blended teaching method has achieved good results and is superior to the traditional teaching method. It is more conducive to students' understanding and mastery of knowledge. The results can provide a reference for further teaching reform of the course "Basic Foundation".

Keywords: Circuit foundation; Online and offline; Blended teaching mode; Curriculum reform

Online publication: October 29, 2025

1. Introduction

Fundamentals of Electric Circuits is a compulsory course for electrical engineering and automation, automation, electronic information engineering, measurement and control technology, and other science and engineering majors. Basic courses, which mainly study the basic laws and analysis and calculation methods of circuits, play an important role in the whole personnel training. On the one hand, it is based on higher mathematics, engineering mathematics, and physics. It is also the basis of the follow-up technical basic courses and professional courses. It is not only an important cornerstone of the electrical knowledge system, but also an important theoretical basis for students to engage in professional and technical work after graduation. It is an important part of students' professional knowledge structure and plays an extremely important role in the development of intelligence and ability.

However, the teaching method of this course is still the traditional teacher-centered teaching method, and students passively accept knowledge. The enthusiasm for previewing before class and reviewing after class is not

high, which leads to a poor effect on the whole teaching. Students' mastery of theoretical knowledge in books is limited, and their ability to use the theoretical knowledge to carry out scientific and technological innovation is even more limited. Therefore, this traditional teaching method also has certain restrictions on the cultivation of students' creativity.

In recent years, especially after the large-scale online teaching practice since 2020, Online and offline blended teaching will become a new trend of teaching reform in colleges and universities in the future ^[1]. Online and offline blended teaching is a teaching method based on traditional classroom teaching. While using the teaching resources of the online teaching platform, the advanced teaching tools are used for online teaching. It is a brand-new teaching mode to realize the organic integration of information technology and traditional classroom teaching. The online and offline blended teaching can not only play the leading role of teachers, It also allows students to learn independently through online rich teaching resources, to achieve personalized learning goals. In this paper, the blended teaching mode is applied to the course of "Circuit Foundation" to explore its impact on the teaching effect. It provides a reference for the teaching reform of this course.

2. Current teaching situation and analysis

In recent years, the teaching reform of the course of Circuit Basis has been increasing. The traditional teaching mode has also made great contributions to the training of electronic and electrical talents in China ^[2]. However, with the increasing development of international exchanges, we must also be aware of the direct gap with the advanced teaching level of foreign countries. We need to actively absorb the experience of foreign curriculum construction. The teaching system and content of the circuit course in our country keep their own characteristics. It gradually emphasizes the subjective status, pays attention to the engineering application background of the circuit, and keeps up with the latest technology. There are still some problems to be solved in the current teaching practice:

- (1) In terms of teaching mode, teachers are still the center, and classroom teaching mostly adopts the teaching method of "cramming". Students still have the phenomenon of passive acceptance of knowledge. This kind of teaching mode is beneficial for teachers to play their leading role in the classroom, but it ignores the initiative and creativity of students. It cannot well reflect the main role of students in classroom teaching, and often gets half the result with twice the effort.
- (2) In terms of curriculum content, the teaching content is still biased towards theory rather than practice. Although in recent years, colleges and universities have increased their investment in practical teaching, the development prospects of experimental teaching content are also very optimistic. However, compared with foreign countries, the content of our circuit experiments is relatively small, and the research is also relatively lacking. There is a clear gap with the latest situation of contemporary scientific and technological development.
- (3) In the teaching evaluation system, the single assessment of students is determined by the final examination. It makes students stick to the problem-solving in the PPT courseware and fall into the lazy learning of score-oriented ^[3]. This evaluation system makes it difficult for students to give full play to their subjective initiative. It is even more difficult to tap the potential of students and cultivate their lifelong learning ability.

3. Design of blended teaching mode of “Circuit foundation”

The teaching process of blended teaching in the course of Circuit Foundation is mainly divided into three stages: before class, during class, and after class. Through problem-oriented online autonomous learning before class, the theoretical teaching of the key and difficult points in class, and the online learning of the comprehensive test after class. It not only enables students to master theoretical knowledge but also cultivates the ability to solve complex problems independently and innovate.

3.1. Design of teaching links

3.1.1. Online autonomous learning stage before class

Teachers will publish learning tasks, teaching courseware, micro-lesson videos, exercise banks, and other supporting curriculum resources according to the syllabus and teaching objectives. On the platform of Superstar Learning Link, Students can use scattered time to study independently according to the published tasks on the mobile phone platform at any time and anywhere. Based on the dormitory, a study group of 4 to 6 people was formed to conduct group discussions. Each student is responsible for different content around a theme. In the process of learning, students can leave messages about their problems in the discussion area, and when answering questions, whether students or teachers. You can get involved. Teachers can summarize the feedback from the discussion area and make necessary adjustments for the next classroom teaching. In this link, the platform will also automatically analyze the online autonomous learning situation of students, as shown in **Figure 1**. Such as the number of videos watched, the length of time watched and the number of discussions participated in. Teachers can understand mastery of knowledge points and teach students in accordance with their aptitude by looking at statistical analysis data.

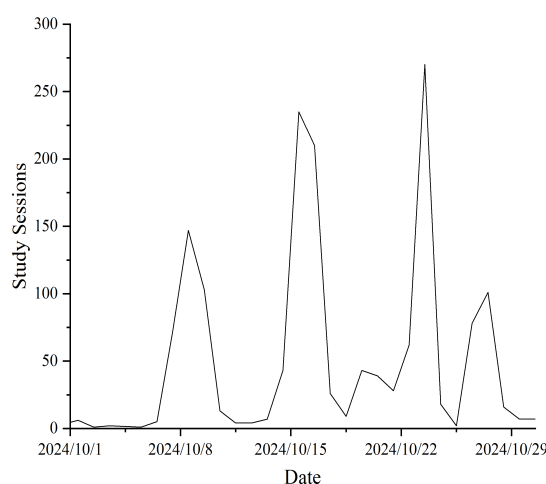


Figure 1. Statistics of students' autonomous learning before class.

3.1.2. The stage of teaching the key and difficult points in class

The second stage of offline teaching is the advanced teaching stage. In the pre-class preview stage, students study independently and discuss in groups according to the tasks issued by teachers. In classroom teaching, using mind mapping, teachers first let each group leader make a simple online learning report. And put forward the problems encountered by the group to help students build a knowledge system. Since students have already learned the basics of this lesson online, Teachers can focus on the key and difficult points of this lesson and the

problems encountered in the group report. The application of the flipped classroom for inquiry-based teaching enables students to have a new understanding of each knowledge point. In the process of teaching, teachers can introduce the frontier and research hotspots of the subject in light of the research progress. Improve students' learning interest and efficiency^[4]. At the same time, we should integrate the education of ideological and political education, humanistic quality, and scientific spirit into classroom teaching through classical cases. Then, in the form of group discussion, students can deepen their understanding and mastery of key knowledge, and at the same time, they should pay attention to the students' team spirit. To mobilize learning initiative, it is more important to guide students' ability to find and solve problems. Cultivate students' ability to acquire new knowledge and innovation. Teachers can also publish questions on the learning link, so that students can consolidate the knowledge points in the form of rushed answers. Before the end of the class, students take an in-class test in the online course to measure the effectiveness of classroom learning.

3.1.3. Online promotion stage after class

According to the completion of the teaching tasks in the first two stages, teachers should summarize the problems and highlights in the teaching process in time. Students can also be surveyed on a small scale, and students can be invited to evaluate the teaching methods and content. Then we should reflect on the teaching carefully, organize and supplement the teaching content in time, to optimize the teaching plan^[5]. It uses the learning platform to arrange comprehensive test questions for students online to consolidate classroom teaching, and at the same time, according to the evaluation results. Teachers can find out the knowledge points that students can't grasp well in time, and answer them through live broadcasting, posting, and discussion. In order to improve the teaching effect, the common questions should be answered centrally, and the individual questions should be answered separately. The platform will automatically count the completion of each homework, as shown in **Figure 2**.

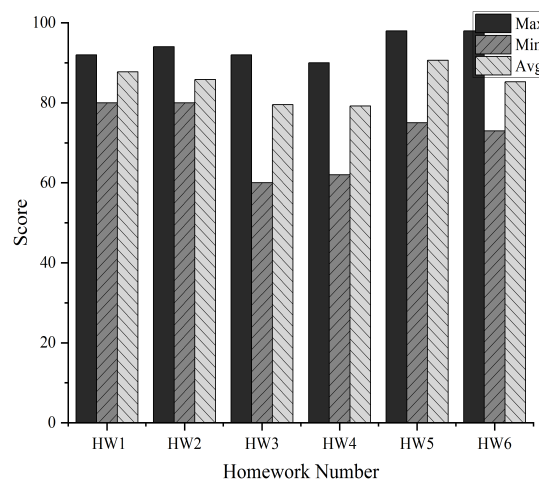


Figure 2. Statistics of students' homework performance.

3.2. Design of assessment and evaluation system

The course assessment method is a combination of process assessment and final assessment. Among them, the process assessment results accounted for 40%, including classroom interaction accounted for 10%, online chapter learning accounted for 20%, and discussion and communication accounted for 20%. Homework accounts for 30%, and ideological and political courses account for 20%. At the end of the course, the final examination is

conducted in a closed-book form, which accounts for 60% of the total score. The combination of various forms of assessment methods greatly reduces the weight ratio of the final examination, so that students can spend their time in peacetime. It has effectively changed the passive examination-oriented learning style of students. In the subsequent optimization of the assessment system, we will further integrate the engineering case resources. The ideological and political elements and professional content are better integrated. Through the continuous optimization of assessment methods, it provides support for the cultivation of innovative and applied talents.

4. Practical effect

The blended teaching mode establishes an effective online and offline communication channel for students, teachers and students, so that students can learn in the classroom at the same time. They can also use the rich online teaching resources for autonomous learning^[6]. From the spring of 2020, the author began to carry out the blended teaching mode for the course of “Circuit Foundation.” After nearly five years of teaching practice, it has been found that the enthusiasm and initiative of students to participate in learning have been significantly improved. Students have changed from passive learning and confused thinking in class to active participation in pre-class learning and classroom teaching. The ability to analyze and solve problems has been significantly improved by boldly communicating their ideas with teachers and classmates. The classroom atmosphere has also been greatly improved.

Through the comparative analysis of the final grades of electrical engineering and automation specialty since 2019, the effectiveness of the blended teaching model has been significantly verified. As can be seen from Figure 3, since the adoption of blended teaching, the proportion of low segments (0-39 points) has shown a continuous downward trend. Among them, the peak proportion of low segments in Grade 2019 is 25.9%, which reflects the problem of insufficient teaching adaptability in the early stage, while the proportion of Grade 2023 has dropped to 2.0%. Explain that blended teaching may help reduce failure rates. The change in the distribution of scores in the middle segment (40–69) showed a gradual dispersion of above-average scores to higher segments. The proportion of high segments (above 70 points) jumped from 17.2% in 2019 to 61.0% in 2023, with the group above 90 points breaking through 6.1% for the first time. It is confirmed that the model plays a promoting role in the cultivation of outstanding talents.

Through the empirical analysis of the five-year performance data, it is confirmed that blended teaching has a significant role in improving the quality of electrical professional training:

- (1) The reduction of the elimination rate of low scores coexists with the breakthrough of high scores, which is in line with the educational equity goal of “supporting the bottom and topping the top”.
- (2) The progressive improvement curve of teaching quality reflects the two-way adaptability of teachers and students.

In future teaching practice, teachers should continue to optimize the mixed teaching mode and design differentiated evaluation tools for the middle section. Reduce the fluctuation of performance distribution, and establish a dynamic adjustment mechanism of blended teaching, combined with learning analysis technology, to achieve precise intervention.

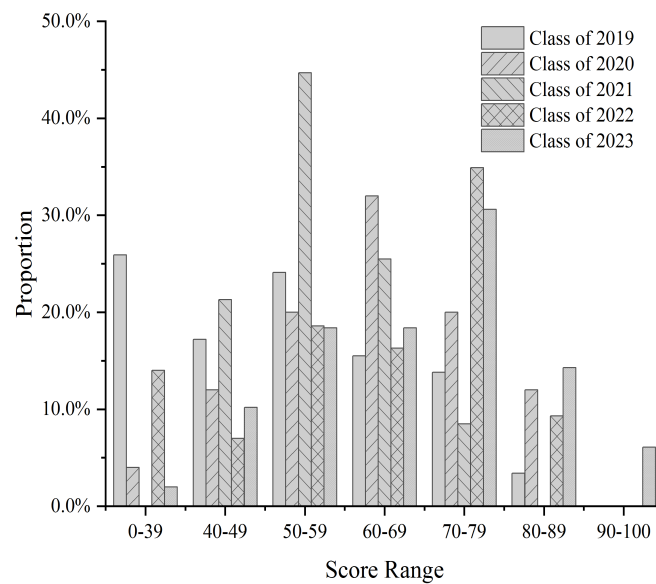


Figure 3. Final Exam Grade Distribution for Electrical Engineering and Automation Cohorts (2019–2023).

5. Conclusion

In this paper, the online and offline blended teaching mode of the course “Circuit Foundation” is constructed based on the learning platform. It uses two kinds of teaching resources of “online and offline”. Realize the teaching mode reform of the three stages of “pre-class online learning + in-class key and difficult points + after-class online promotion.” This mode integrates ideological and political courses into classroom teaching, which not only exercises independent thinking ability and innovative ability, but also improves students’ ideological and political education. It also greatly enhances the students’ sense of teamwork. The assessment and evaluation system has changed from the previous single evaluation method and has combined the process assessment with the final examination. Pay more attention to the comprehensive performance of students in the learning process. The practice effect shows that the teaching effect of blended teaching has been greatly improved compared with the traditional teaching method. It not only fully mobilizes students’ learning initiative and creativity, but it also gives full play to the leading role of teachers in guiding and inspiring the teaching process.

Funding

The First-class Undergraduate Course Training Project of Liupanshui Normal University (Project No.: 2022-03-026); The Guizhou Province First-Class Undergraduate Major Construction Project (Project No.: GZSylzy202104); The Construction Project of First-class Discipline of Liupanshui Normal University (Project No.: LPSSYylzy2007)

Disclosure statement

The authors declare no conflict of interest.

References

- [1] Wang C, Hou H, 2022, Research and Practice of Online and Offline Blended Teaching Mode. *Computer Age*, 2022(03): 107–109.
- [2] Bai Y, Li B, Zhang H, et al., 2020, Research and Reform of Teaching Mode of Basic Circuit Analysis Course. *Theoretical Research and Practice of Innovation and Entrepreneurship*, 3(20): 88–90.
- [3] Wang S, Duan N, Zhang N, 2020, Flipped Classroom Design and Practice of Circuit Course. *Journal of Electrical and Electronic Teaching*, 42(05): 14–17.
- [4] Wu Y, Feng W, 2021, Exploration of Online and Offline Hybrid Teaching Based on Superstar Learning Link in the Teaching of “Analog Electronic Technology”. *Journal of Ningde Normal University (Natural Science Edition)*, 33(02): 206–209 + 219.
- [5] Chai L, Li H, Xia C, 2021, Design of Implementation Scheme of Online and Offline Blended Teaching Mode — Taking the Course of Circuit Analysis as an Example. *Electronic Components and Information Technology*, 5(07): 154–157.
- [6] Guo Z, 2022, Reform and Research on Online and Offline Blended Teaching Mode of Circuit Analysis Course. *Industrial Control Computer*, 35(01): 170–172.

Publisher's note

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

Study on the Path of Financialization of Agricultural, Rural and Farmer Data Assets under the Background of Rural Revitalization Strategy

Jing Zhao*

Shanghai Communist Youth League School, Shanghai 200083, China

**Author to whom correspondence should be addressed.*

Copyright: © 2025 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: With the in-depth implementation of China's rural revitalization strategy, data financialization will become an important means to promote agricultural modernization and rural economic development. At the practical level, the financialization of agricultural, rural and farmer (hereafter referred to as "three rural issues") data can realize the collection and integration of data in agricultural production, circulation, and consumption links by building agricultural data platforms, thereby forming a closed-loop management system. In trust practice, it is particularly important to explore a management model based on data trust. Through data mining technology, a comprehensive analysis of farmers' income levels, production costs, market demand, and other factors is conducted to achieve precision in the design of trust products. Carrying out interdisciplinary cooperative research and integrating relevant theories and methods of agricultural economics, data science, and finance can provide systematic solutions for the financialization of three rural issues. The economic attribute of data has been increasingly recognized and emphasized. Data trust provides a new perspective and new ideas for effectively balancing the data rights and interests structure between data subjects and data controllers, safeguarding data security, and promoting and ensuring the healthy development of the data market. This paper will focus on the new model of three rural issues data governance through data trust.

Keywords: Rural revitalization; Data assets; Financialization

Online publication: November 3, 2025

1. Overview of current domestic and international research

Domestic research in China mainly focuses on the legal perspective of data asset confirmation, and has made breakthroughs in the direction of data asset valuation and book entry, but has not yet solved key issues such as data asset financialization. International research focuses on the field of "information fiduciary" and has formed the academic viewpoint of independent management by fiduciaries, but there is a limitation that research practice is inconsistent with theory. At present, similar projects funded by China's National Social Science Fund focus on the confirmation and valuation of data assets, leaning towards the fields of law and sociology. The breakthrough

of this paper lies in solving the closed-loop design of data financialization, such as the monetization, transaction and income distribution of data assets at the backend. It mainly uses finance and economics to solve the effective transformation of three rural issues data under China's digital strategy, so that data trust can better contribute to the comprehensive revitalization of rural areas.

2. Definition of the scope of research objects and their economic value

Research Objects: The specific research objects are personal agricultural data within agricultural data that have completed rights confirmation, listing, and trading on major local data exchanges. Currently, they mainly focus on agricultural data generated during the production, sales, and other links of agricultural products and local specialty products.

Guided by the goal of data financialization, the overall objective is to realize the monetization, tradability, and circulation of rural, agricultural, and farmer (Three Rural Issues) data assets: to construct a data asset financialization trust model suitable for the Three Rural Issues field and help farmers increase property income. By sorting out the classification characteristics and application scenarios of agricultural data, this paper explains the rights confirmation and transaction mechanism of agricultural data assets (front-end) and proposes an optimized path for the income distribution of agricultural data assets (back-end).

The Three Rural Issues data have significant economic value. Firstly, financial raising using farmers' information can provide financial support for agricultural production^[1]. For example, precise lending methods or supply chain finance methods can set credit limits for farmers based on their historical production information and credit records, and reduce potential risks by virtue of the law of large numbers. For instance, banks can provide loans to farmers after studying their annual income over the past three years and the current market price trend. In addition, information on agricultural product market prices and output can also serve as data support for agricultural product futures trading, thereby enabling farmers to better connect themselves with the market and improve their own benefits. Secondly, the Three Rural Issues data also have great value in the insurance field. Insurance institutions can use the information and data provided by farmers to understand weather conditions, soil quality, epidemic disasters, pest disasters, etc., and then accurately control relevant information through insurance products. This can achieve a more accurate prediction of potential risks, thereby helping to reduce the proportion of compensation costs that insurance companies need to pay.

Furthermore, the introduction of data analysis and intelligent decision-making in agricultural production can significantly improve resource utilization efficiency. The realization of full-chain data sharing through technologies such as the Internet of Things and blockchain not only optimizes the production process but also enables precise fertilization and irrigation, increasing the unit output of crops. Specifically, in a certain region, the implementation of precision agriculture technology has increased the per-mu yield of rice, reduced water resource usage, and promoted sustainable development. The standardization and sharing of agricultural data will bring new business models, thereby spawning new economic value. Platform-based agricultural economy integrates information, such as farmland data and market demand, connects multiple participants, including farmers, processing enterprises, and consumers, and improves the efficiency of the overall supply chain.

3. Technical paths for the financialization of “Three Rural Issues” data assets

3.1. Classification of agricultural data and its main application scenarios

The classification of agricultural data and its main application scenarios include: agricultural production data,

agricultural resource data, supply chain and market data, operation and financial data, scientific research and technical service data, policy and macro data, as well as consumer and terminal data. With the development of smart agriculture (such as digital twins and AI-based plant protection), agricultural data assets are becoming a core element for improving production efficiency, optimizing supply chains, and driving innovation in agricultural finance.

3.2. Transforming agricultural data into effective data assets

To transform agricultural data into effective data assets, it is necessary to complete data collection and standardization, data governance and confirmation of rights, and data value mining. Eventually, it is reflected in the following data asset application scenarios: First, agricultural production and operation. Precision agriculture: Variable fertilization based on soil data to reduce chemical fertilizer use. Second, intelligent breeding: Automatic adjustment of feed formulas through livestock and poultry growth data. Third, supply chain finance: Using production data as collateral to help farmers obtain loans. Insurance institutions use disaster data to develop index insurance (such as automatic claims settlement triggered by drought index). Fourth, market services: Publishing agricultural product price indices to guide farmers to choose the right time for sales. Consumers scan codes for traceability and check the whole production data (such as blockchain + QR code). Fifth, policy and scientific research: The government uses plot-level data to accurately distribute subsidies (such as crop rotation and fallow monitoring). Scientific research institutions share genetic data to accelerate breeding (such as a rice disease-resistant gene bank). Through the above paths, agricultural data can be transformed from raw information into core assets that drive decision-making, reduce costs and create income, ultimately promoting agriculture from “experience-driven” to “data-driven” [2].

3.3. Financialization practice of agricultural data assets

The main financialization practice plan for agricultural data assets is data trust:

- (1) Key steps to realize the financialization of agricultural data: data right confirmation and compliance, data standardization and credibility enhancement, and data valuation and pricing – including the cost approach (cost plus for data collection, storage, and analysis), the income approach (forecasting the cash flow brought by data in the future, such as yield gains from precision farming), and the market approach (referring to transaction prices of similar data, such as the market price of meteorological data).
- (2) The financialization of agricultural, rural and farmer-related data assets requires ecological synergy conditions: the government provides data opening platforms (such as land right confirmation data of the Ministry of Agriculture and Rural Affairs), technology companies provide data analysis tools (such as remote sensing AI and the Internet of Things), and financial institutions design data-driven financial products.

3.4. Exploration of practical models for agricultural data trust

3.4.1. “Government Guidance + Market-Oriented Operation” dual-track trust

- (1) Farmers/cooperatives (data providers) and trustees: licensed trust companies + technology enterprise consortia. Supervisor: local agricultural and rural affairs bureau.
- (2) Operation process: The government provides initial data (such as confirmed land parcel information) and endorses credit; trust companies integrate farmers’ dynamic data (output, agricultural machinery operations); technology enterprises develop data products (such as pest and disease early warning

models); benefits are distributed proportionally (farmers, trusts, and risk reserves each account for a certain proportion).

3.4.2. “Industrial Chain-Led” data trust

Leading agricultural enterprises jointly establish a vertical field data trust with upstream breeding households. Data income rights are used to replace traditional order pledges: farmers invest in the trust with breeding data, and enterprises purchase agricultural products at a premium based on data quality; blockchain deposit ensures data immutability ^[3].

3.4.3. “Inclusive Finance + Data Trust” innovation

Rural commercial banks act as trustees, and farmers’ data trust shares are directly converted into loan quotas. The operation plan can be designed as every 1GB of effective agricultural data, yuan of credit line; a reinsurance mechanism is introduced to hedge against the risk of data valuation fluctuations.

3.4.4. “Carbon Sink Data Trust” (Potential model)

Implementation path includes trust institutions uniformly managing the carbon sink data increased by farmers’ conservation tillage, connecting to the national carbon market for transactions, and returning benefits to farmers; the government additionally issues green agricultural subsidies.

The implementation of China’s agricultural data trust requires the dual-drive of precise policy supply (confirmation + incentive + standard) and hierarchical model innovation (government-led/industry-led/finance-embedded). Priority should be given to pilot projects in large-scale planting areas and regions with improved digital infrastructure. Through the mechanism of “data investment + guaranteed income + excess share,” farmers’ annual income can be increased, while injecting new momentum into rural revitalization ^[4]. The potential scale of China’s agricultural data trust depends on the degree of data assetization, policy promotion speed and market acceptance. Based on existing data and trend analysis, it is expected that a market scale of 300–500 billion yuan may be formed by 2030.

4. Issues to be addressed for the financialization of agriculture, rural areas, and farmers-related data

4.1. Selecting agricultural data assets suitable for the data trust model

The right to benefit from agricultural data (such as remote sensing data subscription fees and agricultural technology service shares) requires long-term and stable operation, but individual farmers or small and medium-sized enterprises are unable to manage it independently. The trustee (trust company) manages the data asset pool uniformly and packages it into securitized products. Farmers, as settlors, receive profit distribution in proportion to their data contribution.

- (1) Applicability to data trading markets (sharing and trading): Scattered agricultural data (such as plot-level soil data and climate records) needs large-scale integration to generate high value, but farmers lack bargaining power. As a neutral third party, the trust acts as an agent for farmers to negotiate with buyers (seed companies, insurance companies) to ensure fair data pricing. Transaction proceeds are automatically distributed through smart contracts (e.g., a fee is paid each time the data is accessed) ^[5].
- (2) Applicability to data pledge financing (credit enhancement): The value of individual farmers’ data

assets is low and the risk control is difficult, but they can be used as collective credit collateral after being scaled up. The trust integrates data from multiple farmers to form an asset package and provides unified pledge to banks. In case of default, the trust can dispose of the data assets (e.g., directional sale to research institutions) ^[6].

- (3) Applicability to carbon sink data financialization: Agricultural carbon sink data (such as soil carbon storage increased by conservation tillage) requires long-term monitoring and certification, and individuals cannot afford the costs. The trust manages carbon sink data, connects to the carbon trading market, and ensures data authenticity and audit compliance. Carbon proceeds are distributed to farmers based on their land area ^[7].

4.2. Policy preparations for establishing data trusts for agriculture, rural areas, and farmer-related data assets

- (1) Legal framework: Clarify the separation of data ownership, right to use, and right to benefit in trust contracts (e.g., farmers retain ownership while trusts obtain operating rights). Compliance must adhere to the Trust Law and Data Security Law, particularly regarding restrictions on cross-border data flows.
- (2) Technical support: Blockchain: Records data contributions and profit distribution to ensure transparency (e.g., on-chain certification via Hyperledger Fabric). Privacy Computing: Enables “data available but not visible” through federated learning and multi-party computation (MPC).
- (3) Benefit distribution mechanism: Dynamic profit sharing, with distribution ratios adjusted based on data usage frequency and derivative value (e.g., remote sensing data used for insurance pricing versus breeding research).
- (4) Incentive mechanism: Farmers who continuously contribute data can obtain additional benefits (such as free agricultural technical services) ^[8]. The data trust model is most suitable for the agricultural data financialization path that requires large-scale integration, long-term operation, and multi-party participation, especially in the fields of securitization, shared transactions, pledge financing, and carbon sink data. Its core value lies in addressing the pain points of agricultural data being “scattered, small-scale, and weak” through neutrality, compliance, and sustainability, thereby maximizing the value of data assets ^[9].

5. Recommendations on the phased advancement of agricultural, rural, and farmer (ARF) data trust

5.1. Gradually realize the regularization of ARF data trust

Establish pilot projects for three models, digital villages, large farms, and smallholder farmers, between 2024 and 2025; banks shall allow the inclusion of data trust shares in the scope of “two rights” mortgage loans in pilot areas. Revise the Trust Law between 2026 and 2027 to add a special chapter on “data trust”; promote the Shanghai Stock Exchange to issue the first agricultural data ABS, such as the “Longping High-Tech Seed Industry Data Trust Beneficiary Certificate.” After 2028, a normalized three-level system of “county-level data trust cooperative - provincial-level data asset exchange - national carbon sink data network will gradually be formed.”

5.2. Optimize trust products

In the design of trust products, variable distribution ratios shall be formulated based on the needs of different

farmers to meet their cash flow requirements. Meanwhile, farmers can obtain real-time updates on the latest market trends and financing status through this platform, making digital financial service information more open and transparent. In addition, integrating blockchain technology into the system helps address the difficulty of altering transactions and enhances public credibility.

5.3. Practice the concepts of green finance and sustainable development

In the future, against the backdrop of the development of big data and artificial intelligence, credit rating and risk management will be empowered by more data, enabling more intelligent rating and risk early warning. Therefore, improving data utilization efficiency, strengthening risk management, and expanding business coverage are key priorities. We advocate that all departments and front-line employees actively explore new cooperation models, such as integrating environmental finance and green finance into rural revitalization development models, to advance agricultural supply-side structural reform and transformation and upgrading^[10].

6. Conclusion

With the continuous advancement of China's rural revitalization strategy, relying on agricultural, rural, and farmers (hereafter referred to as "three rural issues") data resources to solve problems has increasingly become a new approach. In recent years, as data has emerged as a new factor of production, users have increasingly gained the ability to apply and exploit it, granting data the opportunity to be financialized. This process of financialization can not only improve the efficiency of capital resource utilization but also help realize the transformation and development of rural economic formats and boost the process of agricultural modernization^[11].

Traditional agricultural production models are facing enormous pressure due to challenges such as insufficient funds, information asymmetry, and market uncertainty. However, financial models such as trusts can provide more financial resources for agricultural production. As a comprehensive and flexible financial model, trusts can invest in agricultural projects by establishing trust funds, thereby promoting the circulation and value increment of rural assets^[12]. The financialization of "three rural issues" data requires accurate collection and processing. It is necessary to establish intelligent data collection and analysis systems, and use advanced technologies such as big data and cloud computing to sort out data related to agricultural production, operation, and management, thereby forming basic data for investment decision-making^[13]. Such data not only improves the transparency of agricultural products but also enables financial institutions to more accurately evaluate the risks and returns of agricultural projects, thereby reducing loan costs^[14].

The policy context is also a key factor driving the financialization of "three rural issues" data. A series of policies issued by the state, such as the reduction or exemption of agricultural loan handling fees and support for rural financial institutions, have greatly promoted the tilt of financial resources toward the "three rural issues" field. The combination of policy guidance, financial innovation, and market demand has effectively addressed the issue of insufficient rural credit and provided new impetus for agricultural development^[15].

Funding

2025 China Youth Research Association, "Exploration on the Path of New Farmers Serving Comprehensive Rural Revitalization" (Project No.: 2025B44)

Disclosure statement

The author declares no conflict of interest.

References

- [1] Wang F, Tang P, Tang G, 2024, Digital Inclusive Finance Serving Rural Revitalization: Logic, Dilemmas and Solutions. *Dongyue Tribune*, 45(12): 127–135.
- [2] Deng J, Gu Y, 2025, Does Digital Inclusive Finance Promote County-Level Rural Revitalization? *West Forum*, 35(1): 97–111.
- [3] Wang Y, 2024, The Practice of New-Quality Productive Forces in Rural Revitalization: A Case Study of the Integration of E-Commerce and Culture-Tourism. *Rural Economy and Science-Technology*, 35(24): 53–56.
- [4] Wang H, 2024, Providing Strong Financial Support for Rural Industrial Revitalization. *Financial Perspectives Journal*, 2024(2): 3–7.
- [5] Jiang J, Yu W, 2024, Strengthening the Construction of Rural Financial Service System to Promote Rural Industrialization. *China Banking*, 2024(12): 22–25.
- [6] Editorial Department of the Journal, 2024, Optimizing Rural Financial Services to Support Comprehensive Rural Revitalization. *China Banking*, 2024(12): 26–38.
- [7] Li Y, Du Y, Mai X, 2025, Theoretical Logic and Practical Research on the Development of Digital Countryside under the Background of Rural Revitalization. *China Collective Economy*, 2025(1): 5–8.
- [8] Jiang Z, 2024, Injecting Financial Momentum into Rural Revitalization. *Innovation World Weekly*, 2024(12): 87.
- [9] Wang X, Cao X, Huang J, 2024, Improving the Rural Financial Service System: Core Issues, Logical Transformation and Countermeasure Suggestions. *Oriental Forum – Journal of Qingdao University (Social Sciences Edition)*, 2024(6): 45–58 + 157.
- [10] Han Y, He J, 2024, Dilemmas and Promotion Paths of Rural Industry Development under the Background of Rural Revitalization. *Shanxi Agricultural Economy*, 2024(20): 25–28.
- [11] Yang L, 2024, Research on the Path of Rural Revitalization from the Perspective of Financial Empowerment. *Business Economy*, 2024(11): 178–180.
- [12] Zhai Z, 2021, On Data Trust: A New Scheme for Data Governance. *Oriental Law*, 2021(4): 61–76.
- [13] Zhai L, 2021, Analysis on the Development of China's Trust Industry in the Second Quarter of 2021, visited on December 5, 2021, <https://baijiahao.baidu.com/s?id=1708420587938222553&wfr=spider&for=pc>.
- [14] Xing H, 2021, Doubts on the Fiduciary Duty Theory of Data Controllers. *Law and Social Development*, 27(4): 143–158.
- [15] Yi M, Zhang B, Ling M, 2024, An Analysis of Digital Economy Alleviating Agricultural Financing Constraints under the Background of Rural Revitalization Strategy: On Data Assets and Agricultural Financing Costs. *China Chief Financial Officer*, 2024(12): 48–50.

Publisher's note

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

Research on Strategies for Strengthening Computer Professional Thinking Training in Discrete Mathematics Courses

Lijuan Yao*

Taiyuan University, Taiyuan 030032, Shanxi, China

**Author to whom correspondence should be addressed.*

Copyright: © 2025 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: Discrete mathematics, as a core foundational course in computer science, covers set theory, logical reasoning, graph theory, algebraic structures, etc., and is a key carrier for building computer science thinking. At present, there is a problem in discrete mathematics teaching in some universities that emphasizes theoretical derivation over thinking transformation, which makes it difficult for students to effectively connect the course knowledge with subsequent professional courses and engineering practice. This paper analyzes the necessity of strengthening computer professional thinking training in discrete mathematics courses, and elaborates on the core value of discrete mathematics in the cultivation of computer professional thinking from three dimensions: supporting core course learning, cultivating problem modeling ability, and enhancing algorithm design literacy, providing theoretical support for the optimization of teaching strategies for subsequent courses.

Keywords: Discrete Mathematics; Computer Science; Thinking training

Online publication: November 12, 2025

1. Introduction

Discrete mathematics is a fundamental core course for computer science and technology. Its content system covers key modules such as logical reasoning, set theory, graph theory, and algebraic systems, which directly determine the depth of understanding and application ability of students' computer professional knowledge. With the rapid development of fields such as artificial intelligence, big data, and cybersecurity, the computer industry's demand for professional thinking is constantly increasing. It requires not only a solid theoretical foundation but also core thinking abilities such as abstract modeling^[1], logical analysis, and algorithm design. However, in the current teaching of some discrete mathematics courses, there is still a phenomenon of being mainly theoretical and disconnected from professional practice, which makes it difficult for students to transform discrete mathematics knowledge into professional thinking ability and affects subsequent course learning and career development. Therefore, an in-depth analysis of the necessity of strengthening computer

professional thinking training in discrete mathematics courses is of great significance for optimizing course teaching and improving the quality of talent cultivation.

2. The necessity of strengthening computer professional thinking training in Discrete Mathematics courses

2.1. The foundation of knowledge transfer that supports the study of core computer courses

The knowledge system of discrete mathematics serves as the theoretical foundation for many core courses in computer science, and the impact of its thinking training directly affects students' understanding and application abilities in subsequent courses. In the data structures course, the concept of set theory provides theoretical support for the definition of data structures such as linear lists, trees, and graphs, and the contents of path analysis and topological sorting in graph theory are directly applied to the algorithm design of graph structures; In the Database Principles course, relational algebra serves as the theoretical foundation of the query language for relational databases, and its logical reasoning thinking directly determines students' ability to optimize SQL statements; In artificial intelligence courses, propositional logic and predicate logic are the core tools for knowledge representation and reasoning. If students cannot form rigorous logical thinking through discrete mathematics training, it will be difficult for them to understand the principles of key technologies such as neural networks and expert systems ^[2].

In addition, discrete mathematics thinking methods play a crucial role in courses such as operating systems, compiler principles, and network security. Strengthening professional thinking training in discrete mathematics courses can help students establish intrinsic connections among knowledge, form a systematic knowledge system, provide effective knowledge transfer ability for subsequent core course learning, and avoid the learning predicament of "disconnection between theory and application" ^[3]. For example, when students study syntactic analysis in compiler principles, if they have mastered the logical connection between finite automata and regular expressions through discrete mathematics training, they can quickly understand the construction principle of the parser, achieve efficient transfer and application of knowledge, and improve the efficiency and effectiveness of course learning.

2.2. Develop the core ability of abstract modeling of computer problems

One of the core tasks of computer science is to transform practical problems into computable mathematical models, and discrete mathematics is precisely the key carrier for cultivating this ability of abstract modeling. In engineering practice within the field of computer science, whether it involves software system development, algorithm design, or data processing, practical problems must be abstracted into discrete mathematical models first. Solutions are then derived through theoretical analysis and calculation. For example, in the problem of network routing optimization, nodes and links in the network need to be abstracted as vertices and edges in graph theory, the routing selection problem is transformed into the shortest path solution problem, and the optimal routing solution is obtained through Dijkstra's algorithm or Floyd's algorithm ^[4]; In logistics distribution path planning, elements such as delivery points, distribution routes, and time costs need to be abstracted into weighted graph models, and the distribution scheme is optimized through algorithms related to the minimum spanning tree in graph theory or the traveling salesman problem. Set theory, graph theory, algebraic structures, and other contents in the discrete mathematics course provide students with thinking

methods and tools for abstract problems and model construction. Strengthening professional thinking training in the course can guide students to learn to extract key elements from practical problems, ignore irrelevant details, construct mathematical models using symbols, concepts, and methods of discrete mathematics, and gradually form the thinking path of “problem abstraction - model construction - solution verification” [5]. This ability of abstract modeling is not only a core requirement for computer science learning, but also a necessary ability for students to engage in software development, system design, and other jobs in the future. Without this ability, students will have difficulty dealing with complex engineering practice problems and can only remain at the level of simple code writing, unable to achieve the transformation from “technical executor” to “problem solver.”

2.3. Enhance literacy in computer algorithm design and optimization

Algorithms are at the core of computer science, and discrete mathematics is the theoretical foundation of algorithm design and optimization. Strengthening professional thinking training in discrete mathematics courses can effectively enhance students’ algorithmic literacy. Logical reasoning in discrete mathematics provides methods for proving the correctness of algorithms. Through training in propositional logic and predicate logic, students can learn to verify the correctness of algorithms using methods such as mathematical induction and proof by contradiction to avoid system failures caused by logical loopholes in algorithms. The concepts in set theory and graph theory provide ideas for algorithm design. For example, data deduplication algorithms can be designed based on the intersection and union operations of sets, and path finding and topological sorting algorithms can be designed based on the depth-first and breadth-first search of graphs [6]. The concepts of groups, rings, and fields in algebraic structures provide theoretical support for the design of cryptographic algorithms. For example, the security of the RSA encryption algorithm depends on the mathematical properties of the large number factorization problem [7]. In the teaching of discrete mathematics, through the derivation and analysis of classical algorithms, students can be guided to understand the underlying logic of algorithm design and master the thinking method of “problem transformation - mathematical modeling - algorithm implementation - optimization improvement” [8]. For example, when explaining the shortest path algorithm, by analyzing the applicable scenarios and time complexity of Dijkstra’s algorithm and Bellman-Ford’s algorithm, students can learn to choose the appropriate algorithm based on the characteristics of the problem and improve its efficiency through optimization. This cultivation of algorithmic literacy can not only enhance students’ performance in course design and graduation projects, but also lay the foundation for their future work in high-end fields such as algorithm research and development and artificial intelligence, avoiding the shortcoming of “only being able to call existing algorithms but unable to design and optimize them.”

3. Strategies for strengthening computer professional thinking in Discrete Mathematics courses

3.1. Modularized thinking: Breaking down complex problems to build discrete cognition

In discrete mathematics teaching, with the core idea of “breaking down complex problems into independent modules”, students are guided to develop the awareness of “discretization” and “modularization” problem-solving through specific teaching content. For example, when teaching the chapter on combinatorial counting, instead of directly explaining the complex counting problem, break it down into sub-problems such as

permutation and combination calculation, recurrence relation analysis, and application of the principle of tolerance and exclusion, allowing students to gradually master the method of problem decomposition from the whole to the part ^[9]. At the same time, in combination with computer programming scenarios to enhance module cognition, after explaining theoretical knowledge, introduce module decomposition cases in programming design, such as breaking down core algorithms into independent modules like input data processing, logical judgment operations, and output result generation, to help students understand the correspondence between the “subproblems” in discrete mathematics and the “functional modules” in programming ^[10]. Through this “theoretical dissection + practical mapping” teaching approach, students overcome the fear of complex problems, learn to analyze discrete mathematics problems and computer application problems with modular thinking, form a “disassembly - solution - integration” problem-solving path, and lay the foundation for subsequent handling of professional problems such as complex algorithm design and system development.

3.2. Hierarchical and systematic thinking training: Build a logical hierarchy based on modular teaching

Design hierarchical teaching paths around core teaching modules such as mathematical logic and graph theory to guide students to sort out problems in logical hierarchy and cultivate systematic thinking. In the teaching of the mathematical logic chapter, start with the basic concepts of propositional logic, gradually transition to quantitative analysis of predicate logic, and then extend to the rule application of logical reasoning, allowing students to perceive the logical hierarchy of “basic concepts - advanced analysis - comprehensive application” during the learning process; In graph theory teaching, first explain the basic definition and representation of graphs, then delve into algorithmic analysis such as graph traversal and path finding, and finally, in combination with practical scenarios such as network topology design, guide students to handle problems in the hierarchy of “structure definition - algorithm design - scenario application” ^[11]. At the same time, this hierarchical thinking is combined with computer science practice. For example, when explaining cases related to program design, students are guided to divide the program development process into different levels such as requirements analysis, module design, code implementation, test optimization, etc. Each level corresponds to different knowledge modules in discrete mathematics. For example, in the requirements analysis stage, functional logic is sorted out based on mathematical logic. In the module design stage, graph theory is used to optimize the interrelationships between modules. Through this teaching approach, students can gradually develop the habit of handling problems logically and improve their ability to systematically analyze and solve professional problems ^[12].

3.3. Axiomatic thinking enhancement: Deepening the ability of abstract derivation based on Algebraic systems

In the teaching of more abstract chapters such as algebraic systems, with the goal of “strengthening axiomatic thinking”, focus on explaining the basic operation rules and the axiomatic derivation process to help students master the method of deriving complex problems from abstract modules. The teaching process is no longer limited to formula memorization and operation training, but starts from the axiom definitions of the algebraic system, such as the basic operation rules of groups, rings, and fields, and elaborately deduces the theorem proving process under the axiom system, allowing students to understand the logical derivation chain of “axioms - theorems - inferences”. For example, in the teaching of group theory, starting from the four axioms

of group closure, associative law, identity element, and inverse element, the relevant properties such as the order and subgroup of the group are derived, guiding students to think about how to abstract the core features of the algebraic structure through axiom definitions^[13]. At the same time, in combination with abstract problems in computer science, such as the equivalent transformation of logical formulas and the application of solving algebraic equations, let students try to use axiomatic thinking to derive solutions to problems and understand the intrinsic connection between abstract axioms in discrete mathematics and professional problems^[14]. Through this teaching model, students can gradually break away from their reliance on specific examples, learn to analyze complex problems from abstract axioms, enhance their abstract thinking and logical reasoning abilities, and lay the foundation for subsequent study of specialized courses such as cryptography and artificial intelligence that rely on abstract reasoning.

3.4. Synergistic optimization of practice cases and curriculum integration: Lowering the learning threshold and strengthening application cognition

Through the collaborative design of “practical case integration” and “course connection optimization”, discrete mathematics teaching is more in line with the learning path of computer science, and students’ application cognition is strengthened. In terms of adjusting the sequence of course content, the traditional teaching model of “theory first, then application” is broken. Modules closely related to the computer major, such as mathematical logic and set theory, are introduced first, and then gradually transition to abstract theoretical modules such as algebraic systems and combinatorial mathematics. For example, propositional reasoning in mathematical logic is explained first, and conditional judgment statements in programming are combined to help students understand logical relationships. Then delve into the quantitative analysis of predicate logic to lower the threshold for learning abstract theories^[15]. At the same time, incorporate computer application scenario cases into the teaching of each module, such as introducing state transition analysis cases when teaching algorithm design-related content, and explaining state transition logic in programs in combination with knowledge of finite automata; In graph theory teaching, use network topology optimization as a case to have students design optimization schemes using knowledge of graph path finding, minimum spanning tree, etc. Through the teaching method of “learning relevant modules first + integrating practical cases”, students can intuitively perceive the specific applications of discrete mathematics in professional fields such as programming, algorithm design, network optimization, etc., alleviate the resistance to abstract theories, and at the same time achieve a smooth connection between discrete mathematics and subsequent professional courses, and enhance the coherence and effectiveness of knowledge application^[10].

4. Conclusion

Discrete mathematics, as the core vehicle for cultivating thinking in computer science, is directly related to the formation of the core competence of talents in terms of its teaching quality. This paper clarifies the necessity of strengthening professional thinking training from four aspects: supporting core courses, cultivating modeling ability, enhancing algorithmic literacy, and adapting to industry demands, and then proposes four strategies: modular dissection, hierarchical teaching, axiomatic derivation, and coordinated connection between practice and courses. These strategies are both in line with the disciplinary characteristics of discrete mathematics and closely meet the practical needs of computer science, and can provide path references for solving the teaching predicament of discrete mathematics, which is “difficult to learn theoretically and disconnected

from application.” In the future, we can further explore the implementation methods and effect evaluation mechanisms of the strategies in combination with specific teaching scenarios, continuously optimize the teaching mode, contribute to the improvement of the quality of talent cultivation in the computer major, and provide high-quality talents with solid thinking ability for the development of the industry.

Funding

2025 Shanxi Province Higher Education Teaching Reform and Innovation Project, “Reform and Practice of Discrete Mathematics Curriculum for Application-Oriented Undergraduate Computer Major under the Background of ‘101 Plan’” (Project No.: J20250295)

Disclosure statement

The author declares no conflict of interest.

References

- [1] He A, Pan L, Li T, 2025, Research on Teaching Innovation Reform of Discrete Mathematics Oriented by Computational Cognitive Thinking. *Educational Teaching Forum*, 2025(20): 67–71.
- [2] Zhang S, Gao G, Guo X, 2024, Research on Inquiry-Based Teaching Mode Based on Computational Thinking Cultivation. *Journal of Henan Institute of Science and Technology*, 44(4): 8–16.
- [3] Zhao J, Fan L, Zhang T, et al., 2024, Research on Teaching Mode of Discrete Mathematics Based on Computational Thinking. *Neijiang Science and Technology*, 45(3): 52–53 + 56.
- [4] Lu S, Liu Q, 2023, Journal of Guangxi Radio and Television University. *Journal of Guangxi Radio and Television University*, 34(4): 83–87.
- [5] Dong L, Yang M, Wen Z, 2023, Practice and Analysis of Teaching Reform in Discrete Mathematics. *Modern Vocational Education*, 2023(19): 129–132.
- [6] Chen W, Zhou X, 2023, A Teaching Exploration of the Integration of Programming and Discrete Mathematics. *Computer Education*, 2023(3): 76–80.
- [7] He C, Liu D, 2023, Computational Thinking and Course-Based Ideological and Political Education in Discrete Mathematics Curriculum. *Computer Education*, 2023(2): 79–82.
- [8] Zhou X, Qiao H, Li L, 2022, Cultivation of Computational Thinking in Combinatorial Counting Teaching in Discrete Mathematics Curriculum. *Computer Education*, 2022(5): 1–5.
- [9] Zhang R, Zhang F, Yang G, 2021, Research on Stratified Teaching of Discrete Mathematics Based on Computational Thinking Ability Cultivation. *Zhengzhou Normal Education*, 10(6): 70–72.
- [10] Jia J, Li W, 2021, Teaching Reform of Discrete Mathematics Based on Computational Thinking for Ability Development. *Computer Education*, 2021(9): 152–155.
- [11] Wu Z, 2021, Research on the Necessity of Embedding Applied Thinking into Discrete Mathematics Teaching. *Science & Technology Vision*, 2021(16): 29–30.
- [12] Liu F, 2021, Cultivating Computational Thinking in Propositional Logic of Discrete Mathematics Curriculum. *Computer Education*, 2021(4): 151–154.
- [13] Hou Y, 2020, Analysis of Discrete Mathematics Teaching in the Era of Big Data. *New Curriculum Teaching*

(Electronic Edition), 2020(22): 116–117.

- [14] Zhang Y, Bao Y, 2020, Research on Computational Thinking Oriented Discrete Mathematics Teaching Mode. Science & Technology Wind, 2020(21): 38–39.
- [15] Jin Y, Hu Y, Tian Q, et al., 2020, A Case Study of Discrete Mathematics Teaching: Taking Equivalence Relations as an Example. Educational Teaching Forum, 2020(29): 264–266.

Publisher's note

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

Exploration and Research on the “AI +” Talent Cultivation Model for Computer Software Engineering majors in Higher Education Institutions

Huiying Zhang*, Haoyi Xie, Yule Sun

Nanjing Tech University Pujiang Institute, Nanjing 211200, Jiangsu

**Author to whom correspondence should be addressed.*

Copyright: © 2025 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: Against the backdrop of the advancement of the national “AI +” strategy and the intelligent upgrade of the software industry, enterprises have an increasingly urgent demand for compound talents who “understand development and are intelligent”, but the traditional training model of software engineering in colleges and universities has obvious shortcomings and is difficult to meet this demand. This paper takes the computer software engineering major in application-oriented universities as the research object, systematically sorts out the problems existing in the current training mode, and proposes targeted four-dimensional solutions of “curriculum reconstruction, practice strengthening, faculty construction, and evaluation optimization”. Practice has shown that this model can effectively enhance students’ interdisciplinary application ability and job fit, providing a practical reference for the reform of software engineering education.

Keywords: Software Engineering; AI +; Talent development model; Curriculum integration; School-enterprise collaboration

Online publication: November 14, 2025

1. Introduction

With the implementation of policies such as the “Next Generation Artificial Intelligence Development Plan” and the “14th Five-Year Plan for Software Industry Development”, the deep integration of artificial intelligence and the software industry has become the core direction of industrial upgrading, and the software industry has transformed from traditional coding to intelligent development. Enterprises are in urgent need of compound talents who master development technologies such as Java and Python and can apply machine learning and computer vision to solve practical engineering problems, such as AI-driven software systems^[1].

However, there is a significant mismatch between the supply and demand of software engineering

professionals in colleges and universities ^[2]. On the one hand, the curriculum system is dominated by single-discipline knowledge, and AI-related content is mostly elective and disconnected from core courses such as software design and testing, making it difficult for students to combine AI technology with software engineering practice ^[3,4]. On the other hand, practical teaching often uses simulated projects and lacks real “AI + software engineering” integration scenarios, resulting in students having a long time to adapt to their jobs after graduation. Therefore, exploring the “AI +” talent cultivation model has become the key to resolving the contradiction between educational supply and industrial demand ^[5,6].

2. Problems Existing in the cultivation of “AI +” talents in software engineering at present

2.1. Low integration of AI with software engineering courses

Core software engineering courses, such as Software Project Management and Software Development Technology, focus on coding and process management. AI courses such as Fundamentals of Machine Learning are mostly general elective courses and do not incorporate key elements of the software development life cycle. For example, Software Testing Techniques still mainly focus on manual test case design and do not introduce AI automated testing tools such as Applitools Eyes ^[4]. Software Design does not cover intelligent architecture optimization based on reinforcement learning, and students cannot translate AI technology into engineering capabilities. Meanwhile, the course lags behind industry development. Currently, AI technology has evolved towards large model development and low-code platform intelligent plugins, but most universities still mainly teach traditional machine learning algorithms, such as decision trees and SVM, and do not cover the application of AI-generated code tools such as ChatGPT-assisted development and CodeLlama. There is a gap between students’ knowledge reserves and the demands of enterprises ^[7].

2.2. The practical teaching scenarios are virtual, and the collaboration between schools and enterprises is shallow

There are “two virtual” issues in the practical process: First, there is a “virtual project.” Most practical projects are simulated scenarios, such as the development of library management systems, without integrating AI technology, which cannot train students’ ability to solve engineering problems with AI ^[8]. Second, the cooperation between the school and the enterprise mostly remains at the level of lectures by enterprise experts and short-term visits by students, without establishing a deep collaborative mechanism of jointly designing courses, jointly guiding projects, and jointly evaluating achievements. Students have difficulty accessing real “AI + software” projects, such as the development of intelligent operation and maintenance systems and the design of industrial software AI modules. The practical skills are hard to meet the job requirements ^[9].

2.3. The teaching staff has weak interdisciplinary capabilities

Most of the current faculty members have a single background. Software engineering teachers are familiar with development techniques but lack practical experience in AI and are unable to efficiently teach integrated courses such as AI-driven software optimization ^[10]. AI teachers are good at algorithmic theory but not familiar with software engineering processes, making it difficult for them to guide students through the entire process from AI models to software implementation. In addition, teachers have few opportunities to practice in enterprises. Most of them have not participated in “AI + software” industry projects. Teaching cases are mainly based on textbook

examples, lacking practicality and unable to provide students with teaching guidance that is in line with industry reality ^[11].

2.4. The evaluation system emphasizes theory over application

The traditional evaluation system, which is based on test scores plus code submission, has obvious limitations. First, the evaluation dimension is single and does not include indicators such as the application effect of AI technology and the degree of project engineering, making it impossible to comprehensively measure students' interdisciplinary abilities. Second, the evaluation subjects are limited, scoring only by teachers within the school, assessing only the correctness of code operation, without evaluating core indicators of concern to enterprises such as concurrent processing capacity of the system, making it difficult to reflect students' true abilities. The evaluation results are disconnected from job requirements without the inclusion of enterprise experts' opinions ^[12,13].

3. Countermeasures for optimizing the cultivation of “AI +” talents in software engineering programs in colleges and universities

3.1. Reconstruct the integrated curriculum system of AI + software engineering

With the software development life cycle as the logical thread, break down AI technology into five modules: requirements analysis, design, development, testing, operation and maintenance, and embed them in core courses. Add an “AI Requirements Forecasting” module to the Introduction to Software Engineering to guide students to predict software functional requirements using regression analysis algorithms. In Software Design, add “Intelligent Architecture Design” and teach to optimize module division using reinforcement learning; Introduce the application of AI-generated code tools in Software Development Technology to train students to use AI to assist in development. In Software Testing Technology, incorporate “AI Automated testing” to enable students to develop test tools based on image recognition, and in Software Operation and Maintenance, add “intelligent Fault prediction” to implement software log anomaly detection using LSTM algorithms. At the same time, “AI + Software Engineering” elective directions such as “Intelligent Software Development” and “AI-driven Testing and Operations” are set up, along with cutting-edge courses such as “Large Models and Software Development” to fill the knowledge gap.

3.2. Strengthen practical teaching and deepen school-enterprise collaboration and platform construction

- (1) Build practice bases, sign cooperation agreements with local IT enterprises, enterprises provide real projects such as system intelligent monitoring software development, send engineers as off-campus mentors, universities organize students to participate in development in the form of project teams, submit requirements documents, design plans, code implementation, test reports and other complete engineering results.
- (2) Upgrade the on-campus experimental platform, build an “AI + software engineering” integrated laboratory, configure GPU servers supporting TensorFlow ^[14] and PyTorch ^[15], deploy industrial-grade development environments such as Jenkins and JIRA, and develop virtual simulation project libraries such as medical image analysis software, To make up for the long cycle and limited participation of enterprise projects.
- (3) Implement progressive practice projects. At the basic level, focus on single technology integration

projects such as CNN-based software development. At the advanced level, focus on system module integration projects. At the advanced level, connect with real enterprise demands such as intelligent monitoring software for industrial equipment to achieve step-by-step improvement of students' abilities.

3.3. Build a dual-qualified, interdisciplinary teaching team

- (1) Conduct in-school teacher training. Regularly organize software engineering teachers to participate in AI core technology training, such as deep learning and computer vision. Only those who pass the assessment can undertake integrated courses. Teachers are required to be on secondments to enterprises for 2–3 months every two years to participate in the research and development of “AI + software” projects, such as the development of intelligent testing tools, and convert practical experience into teaching cases.
- (2) Adopt a combination of an introduction and a part-time approach. Introduce high-level talents with a doctoral degree in software engineering and experience in AI enterprise research and development to be responsible for teaching core integrated courses. Hire enterprise AI software research and development leaders as industry professors and give 2–3 special lectures each semester to guide students' advanced projects.
- (3) Promote cross-university faculty exchanges, establish cooperation with top universities at home and abroad, send teachers to exchange experiences in the design of “AI + software engineering” courses, share teaching resources, and enhance the overall level of the faculty team.

3.4. Establish a diversified and dynamic evaluation system

- (1) Expand the evaluation dimensions and set indicators in three aspects: knowledge, ability, and quality. The knowledge dimension includes integrated course examination results and AI technology theory defense. The ability dimension covers project achievements such as requirement document completeness, code quality, and AI algorithm effect. The quality dimension involves teamwork, project progress management, and document standardization to comprehensively measure students' comprehensive abilities.
- (2) Introduce multiple evaluation subjects: in-school teachers evaluate theoretical mastery and code standardization, enterprise mentors evaluate the degree of project engineering and job fit, and students evaluate team collaboration performance to form a “three-party evaluation” mechanism to ensure that the evaluation results are in line with job requirements
- (3) Improve the dynamic feedback optimization mechanism. At the end of each semester, collect student learning feedback, enterprise employment evaluation, and teacher teaching reflection, and adjust the course content in a timely manner (such as adding the “large model software application” module) and optimize the practical projects to achieve continuous iteration of the training model.

4. Conclusion

This paper addresses the pain points of “AI +” talent cultivation in software engineering programs in colleges and universities and proposes a four-dimensional optimization strategy of curriculum, practice, faculty, and evaluation. The core is to break the traditional model of the separation of AI and software engineering, and cultivate compound talents who understand development, are intelligent, and can be implemented through

curriculum integration, school-enterprise collaboration, faculty upgrading and evaluation innovation. In the future, the scope of school-enterprise cooperation can be further expanded, industrial colleges can be established to achieve “order-based” training, and the curriculum content can be dynamically updated to adapt to the evolution of AI technology, continuously improving the quality of talent cultivation and providing intellectual support for the upgrading of the software industry.

Funding

2025 China University Computer Basic Education Society Project (Project No.: 2025-AFCEC-113); Nanjing Tech University Pujiang College Young Backbone Teachers Project (Project No.: 2025PJYQ04); Key Natural Science Project of Nanjing Tech University Pujiang College 2024 (Project No.: njpj2024-1-01).

Disclosure statement

The authors declare no conflict of interest.

References

- [1] Yang C, Chi R, Li C, 2020, Research on the Training Mode and Strategy of Software Engineering Technology. *Journal of Shenzhen Polytechnic University*, 24(5): 99–104.
- [2] Dong Z, Lin Y, Cong R, 2025, New Engineering Curriculum Optimization and Evaluation System Reconstruction from the Perspective of Systems Theory: A Case Study of Computer Vision Course. *Computer Education*, 2025(6): 168–172 + 177.
- [3] Lang C, Qian H, Wu S, et al., 25, Research on the Training Mode of Computer-related Compound Talents in the Context of New Engineering. *Electronic Components and Information Technology*, 9(1): 234–237.
- [4] Liu Y, Wei J, Li J, 2014, Research and Application of Intelligent Testing Tools and Processes. *Oil and Gas Well Testing*, 23(2): 71–74 + 78.
- [5] Zhang H, 2023, Research on the Training of Computer Talents in Private Colleges. *Electronics Science Technology and Application*, 2023(10): 71–73.
- [6] Zhang H, Mu Y, 2024, Research on Curriculum Construction of Artificial Intelligence under the Background of New Engineering. *Education Reform and Development*, 2024(4): 108–111.
- [7] Tian C, Chen L, Wang S, et al., 25, Macrocell Layout Method for Intelligent Chip Based on Graph Convolutional Network and Reinforcement Learning. *Shanghai Aerospace (Chinese and English)*, 42(5): 167–177.
- [8] Zhang H, 2024, Research on the Application-oriented Talent Cultivation System of Software Engineering in Independent Colleges. *Internet Weekly*, 2024(1): 65–67.
- [9] Harris N, 2025, AI Technology in the Application of Computer Software Development. *Information Recording Materials*, 26(10): 121–123.
- [10] Zhang H, 2022, Research on the Reform of Database Engineering Teaching in Applied Undergraduate Education. *Jiangsu Science and Technology Information*, 39(17): 53–56.
- [11] Cai Y, Zeng A, 2025, “12345” Integration of Government, Industry, Academia, Research and Application for Innovative Talent Cultivation in Software Engineering. *Computer Education*, 2025(9): 131–135.
- [12] Chen H, Du J, 2025, Exploration of Teaching Reform of “Time Series Analysis” Course Based on “SARIMA-BP/

- SVM/RF” Joint Model and R Language. *Chinese Journal of Health Statistics*, 42(4): 632–636.
- [13] Shen H, Chen Y, Gu P, et al., 2020, Case Study and Practice of “Disaster Monitoring and Early Warning Technology” Course Based on LSTM Model: Taking Rainfall Prediction as an Example. *Industrial Control Computers*, 38(8): 106–108.
- [14] Gao Z, Tang L, Gu R, 2023, Exploring the Development of an Innovative Case Curriculum Standard for “TensorFlow Basic Practice”. *Knowledge Library*, 2023(3): 37–39.
- [15] Lu J, Wang L, Hou M, 2022, Application and Prospect of Deep Learning-based PyTorch in Flight Safety Teaching. *Educational Teaching Forum*, 2022(46): 137–140.

Publisher’s note

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

Teaching Design of Ideological and Political Education in College English Curriculum in Civil Aviation Vocational Colleges Based on the “Three-Approach and Three-Style” Paradigm

Yuanlin Shi*

Shanghai Civil Aviation College, Shanghai 200232, China

**Author to whom correspondence should be addressed.*

Copyright: © 2025 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: This paper first provides an overview of the “Three-Approach and Three-Style” paradigm^[1], and then analyzes the principles of ideological and political education teaching design in college English courses in civil aviation vocational colleges based on this paradigm. Finally, it elaborates on the practical strategies for ideological and political education teaching design in college English courses in civil aviation vocational colleges from aspects such as constructing the teaching content of English courses with ideological and political elements, cultivating students’ professional ethics and qualities, and innovating the teaching methods of English courses with ideological and political elements^[2]. The aim is to enable students to enhance their comprehensive qualities through the ideological and political education in these courses.

Keywords: “Three-Approach and Three-Style” paradigm; Civil aviation vocational colleges; Ideological and political education in college English courses

Online publication: November 12, 2025

1. Overview of the “Three-Approach and Three-Style” paradigm

Centered around the core concept of “imparting moral principles through teaching, cultivating virtues through teaching, and making learning enjoyable through teaching,” this paradigm ingeniously integrates ideological and political education elements into professional courses, aiming to cultivate civil aviation talents who possess both professional skills and noble moral characters.

The concept of “Three-Approach,” namely imparting moral principles through teaching, cultivating virtues through teaching, and making learning enjoyable through teaching, emphasizes that in the teaching process, teachers should not only impart knowledge but also guide students to comprehend principles, cultivate virtues, and enjoy the pleasure of learning.

The “Three-Style” techniques, namely the “finishing-touch” style, the “special-topic integration” style, and

the “element combination” style, provide specific approaches for integrating ideological and political education into professional courses ^[1].

2. Principles of teaching design

2.1. Adherence to the Principle of Integration

In the ideological and political teaching design of college English courses in civil aviation vocational colleges, ideological and political education elements should be deeply integrated with the content of college English courses, rather than simply being superimposed ^[3]. Teachers should explore the ideological and political connotations in English textbooks, such as professional spirit and international vision, and combine them with civil aviation professional knowledge to form ideological and political teaching content with civil aviation characteristics ^[2].

2.2. Adherence to the Principle of Targeting

In light of the characteristics and needs of students in civil aviation vocational colleges, teachers should design ideological and political teaching content that conforms to the professional background of civil aviation vocational colleges and the future development of students. For example, by using materials such as civil aviation industry cases and international aviation regulations, students’ professional identity and legal awareness can be enhanced.

2.3. Adherence to the Principle of Enlightenment

During the process of English ideological and political teaching, teachers should focus on inspiring students’ thinking and cultivating their critical thinking and problem-solving abilities ^[4]. Through interactive methods such as group discussions and role-playing, teachers can guide students to think deeply about issues, such as professional ethics and social responsibility in the civil aviation industry, enabling them to form their own insights.

2.4. Adherence to the Principle of Practicality

When designing courses, teachers should combine the practical teaching resources of civil aviation vocational colleges and design practical ideological and political teaching activities. For instance, organizing students to visit civil aviation enterprises and participate in volunteer services can allow students to experience the significance of ideological and political education in practice, thereby improving their professional qualities and sense of social responsibility.

2.5. Adherence to the Principle of Innovation

Teachers should continuously explore and innovate the methods and means of ideological and political teaching. For example, by utilizing new media technologies and virtual reality technologies, the attractiveness and appeal of ideological and political teaching can be enhanced, making ideological and political education more relevant to students’ learning needs and daily lives ^[3].

3. Practical strategies for teaching design

3.1. Three-approach

3.1.1. Imparting moral principles through teaching

- (1) Building a curriculum ideological and political resource library to enrich teaching resources

To ensure the richness of curriculum resources, teachers should rely on the curriculum characteristics and resource advantages of civil aviation vocational colleges. Closely centered around the uniqueness of the civil aviation industry, they need to develop an online resource library that combines professionalism with ideological and political elements. This resource library should cover a wide range of rich materials, including the history of civil aviation development, industry norms, safety culture, international civil aviation cooperation, deeds of civil aviation heroes, and the contemporary spirit of civil aviation. Moreover, these materials should be presented in various forms, such as videos, audios, and pictures, forming a series of teaching resource packages that are closely related to the course content and have distinct ideological and political elements. This can solve the problem of the lack of industry ideological and political materials in traditional English textbooks. It not only provides support for teachers' teaching but also offers students rich and diverse learning materials ^[4].

- (2) Integrating ideological and political elements with curriculum content to improve the teaching system

In the design of curriculum content, teachers should focus on closely integrating ideological and political elements with civil aviation professional knowledge to achieve in-depth integration. When designing the curriculum, teachers should conduct an in-depth analysis of the course knowledge content, identify the integration points between ideological and political elements and the curriculum content, and naturally integrate the ideological and political elements into all aspects of English teaching. At the same time, in line with the key points of curriculum ideological and political education, they should improve the curriculum content system centered on the cultivation of English listening, speaking, reading, writing, and translation skills. This ensures that students can not only master professional knowledge but also receive profound ideological and political education ^[5].

- (3) Conducting the construction of curriculum ideological and political content based on the "One core, two mainlines, and three dimensions"

In the construction of curriculum ideological and political education, teachers should clarify the core of practicing socialist core values and integrate this concept throughout the entire process of educational teaching, including curriculum outlines, teaching plans, teaching processes, and teaching evaluations. At the same time, two main lines should be established: one is to promote patriotism. By narrating the development history, achievements, and contributions of Chinese civil aviation, students' patriotic enthusiasm can be inspired; the other is to cultivate cross-cultural competence. By comparing the cultures and service concepts of the domestic and international civil aviation industries, students' international perspectives and cross-cultural communication abilities can be enhanced. On this basis, starting from three dimensions-value shaping, the imparting of humanistic knowledge, and the cultivation of language communication, the cultivation of students' ideological and political qualities and humanistic qualities should be comprehensively strengthened. This helps to enhance their professional sense of responsibility, social sense of responsibility, and moral sense, enrich their understanding of civil aviation industry culture, improve their practical language application abilities, and lay a solid foundation for their future career development ^[6].

- (4) Continuously optimizing curriculum resources to improve the effectiveness of ideological and political

teaching

To ensure the continuous improvement of the effectiveness of ideological and political teaching, teachers should regularly update and optimize curriculum resources. With the development of the civil aviation industry and the new requirements of ideological and political education, teachers should promptly incorporate new ideological and political elements and professional knowledge into curriculum resources, ensuring that the course content remains timely and cutting-edge. At the same time, combined with feedback from practical teaching and teaching effect evaluations, continuous improvements and refinements should be made to the curriculum resources to ensure the continuous enhancement of the effectiveness of ideological and political teaching. This can not only guarantee the timeliness and pertinence of curriculum resources but also provide students with a higher-quality and efficient English learning experience ^[7].

Case: In the college English courses of civil aviation vocational colleges, teachers select English materials related to aviation safety, such as the safety guidelines of the International Civil Aviation Organization (ICAO), and integrate ideological and political education elements into the teaching. For example, when explaining the theme of “Air Traffic Safety,” teachers not only analyze the professional terms and sentence structures in the English original text but also guide students to think about the importance of aviation safety for the country and the safety of people’s lives and property, as well as the responsibilities and missions that civil aviation practitioners should bear. Through role-playing, students use English to simulate the handling process of aviation safety incidents. This not only exercises their English application abilities but also enhances their safety awareness and sense of social responsibility, achieving the goal of “imparting moral principles through teaching” ^[8].

3.1.2. Imparting virtues through teaching

(1) Creating professional ethics scenarios to enhance students’ professional ethics awareness

To cultivate students’ professional ethics awareness, teachers should simulate real scenarios in civil aviation work, such as flight delay handling and passenger complaint response. Let students play different roles in these scenarios to experience the importance of professional ethics in actual work. In this way, students can enhance their professional ethics awareness in practice and clarify their responsibilities and commitments in the civil aviation industry ^[9].

(2) Holding professional ethics English debates to improve students’ professional ethics cognition

Various complex situations may arise in civil aviation work. Teachers should utilize college English classes to organize English debates with professional ethics as the theme. Through debates, students can deeply explore professional ethics issues in the civil aviation industry, such as honest service and safety responsibility. This helps deepen students’ cognition and understanding of professional ethics, exercise their English expression abilities, and at the same time promote the improvement of their professional ethics literacy ^[10].

(3) Organizing professional ethics practice activities to elevate students’ professional ethics literacy

Students in civil aviation vocational colleges will eventually enter the job market. To endow students with good moral qualities, teachers should encourage them to participate in volunteer services and social practice activities in the civil aviation industry, putting professional ethics concepts into practice. Through practical activities, students can personally experience the specific application of professional ethics in the civil aviation industry, cultivate their sense of social responsibility and dedication spirit, and enhance their professional ethics literacy ^[11].

Case: In the “College English 3” course, the teacher designed a teaching activity named “Civil Aviation Ethics Simulation”. Students were divided into different groups to simulate civil aviation work scenarios, such as airport security checks and flight scheduling, and incorporated professional ethics challenges into these simulations ^[12]. For example, in the security check simulation, one student played the role of a passenger trying to carry prohibited items on board, while another student played the role of a security checker and used English to dissuade the passenger: “Sir, according to the regulations, this item is prohibited from being carried on board. Please cooperate with our work.” Through such simulation drills, students not only exercised their English communication abilities but also gained a deeper understanding of the importance of professional ethics in civil aviation, such as a sense of responsibility and integrity, achieving the teaching goal of imparting virtues through teaching ^[13].

3.1.3. Making learning enjoyable through teaching

(1) The pre-study, discussion, and feedback cycle teaching method

To ensure students’ learning quality, teachers should adopt the pre-study, discussion, and feedback cycle teaching method to enable students to form a virtuous learning cycle. Before class, teachers release pre-study materials related to the civil aviation professional spirit to guide students to have a preliminary understanding of the classroom theme. During class, through group discussions or class seminars, students are encouraged to deeply explore the ideological and political elements in the pre-study materials, promoting the collision of ideas and knowledge internalization. After class, students are encouraged to write learning reflections or provide online feedback. Teachers then organize and analyze the feedback to provide directions for improvement in the next round of teaching. Thus, this cycle teaching method not only strengthens students’ pre-study effects but also promotes the deepening of ideological and political education through discussions and feedback ^[14].

(2) The situational simulation and role-play interactive teaching method

In ideological and political education, teachers should attach importance to perception and experience. Through the situational simulation and role-play interactive teaching method, students’ good virtues can be cultivated. In English teaching, teachers should simulate civil aviation work scenarios and let students play different roles for interaction. This enables students to deeply comprehend the essence of ideological and political education in practice and exercise their language expression and emergency response abilities.

(3) The ideological and political theme project-based learning method

In the ideological and political teaching of college English courses, teachers should give full play to students’ initiative and involve them in learning practices. For this purpose, teachers should design a series of project-based learning tasks centered around ideological and political themes, allowing students to work in groups around the theme to jointly complete the projects, such as planning a themed speech or making a micro-film. In this way, during the process of project-based learning, students can not only deepen their understanding of ideological and political content but also cultivate their team collaboration abilities, innovative thinking abilities, and practical abilities.

Case: In the classroom of “College English 3”, the teacher set up a “Civil Aviation English Corner” to create a relaxed and pleasant English communication environment and enhance students’ language abilities and ideological and political literacy. During the activity, students discussed the theme of “Global Aviation Trends and Challenges” in English. For example, Student A shared: “Technological advancements, such as autonomous

drones, are revolutionizing the aviation industry.” However, Student B retorted: “However, human factors, like pilot training and safety culture, remain crucial for flight safety.” Through this debate activity, students not only exercised their oral English in English communication but also incorporated ideological and political education related to civil aviation safety and responsibility into the discussion. Making learning enjoyable has achieved remarkable results.

3.2. Three-style

Taking the textbook *New Direction: Civil Aviation -- Characteristic College English* as an example, through the “finishing-touch” style, “element-combination” style, and “special-topic embedding” style, students can understand the necessary knowledge, skills, and psychological preparations during the transition from college students to job positions^[5]. This helps improve students’ extensive reading ability, enabling them to summarize the main idea of a text and extract the theme by using topic sentences and skimming techniques^[11].

Enable students to learn the necessary knowledge, skills, and psychological preparations as airline employees: Students will learn the knowledge, skills, and psychological preparations required for airline employees. They will also learn vocabulary related to airline services and be able to read and understand the basic materials about airline staff qualifications.

Understand the causes, impacts, and countermeasures of flight delays and cancellations: Students will understand the reasons, impacts, and countermeasures for flight delays and cancellations, and master the English expressions related to flight delays and cancellations.

Cultivate various qualities and abilities: Cultivate students’ sense of responsibility, empathy, service awareness, good communication skills, teamwork, and problem-solving abilities. Also, enhance their service qualities in service-oriented and safety-related occupations, improve their cross-cultural communication levels, and temper their scientific spirit, labor spirit, and innovative spirit^[12].

3.3. Evaluation guidance: Improve college English teaching evaluation and further optimize English ideological and political teaching

- (1) Build a diversified evaluation content to ensure the comprehensiveness of the evaluation

To better understand the teaching design effect of ideological and political education in college English courses in civil aviation vocational colleges based on the “Three-Approach and Three-Style” paradigm, the evaluation content should be closely related to the goals of curriculum ideological and political education. Combine moral education with intellectual education and build multi-dimensional indicators such as students’ learning attitudes, classroom performances, compliance with rules, teamwork, international perspectives, and civil aviation spirits. This ensures the comprehensiveness and scientific nature of the evaluation.

- (2) Enrich evaluation methods to form comprehensive evaluation information

The evaluation of the ideological and political teaching design of college English courses in civil aviation vocational colleges based on the “Three-Approach and Three-Style” paradigm should be diversified to form comprehensive and objective evaluation information. In addition to the traditional final exam evaluation, teachers should also pay attention to formative evaluation, such as daily observations, homework analyses, and classroom interactions^[13].

- (3) Build a diversified evaluation subject to promote the continuous optimization of English curriculum ideological and political education

To ensure the objectivity of the evaluation, teachers should build a diversified evaluation subject group consisting of teachers, students, and domestic and foreign peers. Teachers should act as the leaders of the evaluation, comprehensively assessing students' learning attitudes, classroom performances, etc. Students should participate in peer evaluations and self-evaluations to cultivate their self-reflection and critical thinking abilities ^[14].

4. Conclusion

The teaching design of ideological and political education in college English courses in civil aviation vocational colleges based on the “Three-Approach and Three-Style” paradigm not only enriches the connotation of English teaching but also takes a solid step in cultivating compound talents with international perspectives and civil aviation spirits. By integrating ideological and political education into English teaching, teachers not only improve students' language abilities but also subtly shape their correct worldviews, outlooks on life, and values. With the continuous deepening of educational reforms, teachers should continuously promote the organic combination of English teaching and ideological and political education, contributing to the cultivation of high-quality skilled talents with international perspectives, civil aviation spirits, and ideological and political literacy ^[15].

Disclosure statement

The author declares no conflict of interest.

References

- [1] Teng Y, Zhang Y, Xiao G, 2018, Reform of “Tao, Fa, Shu, Qi” in the “Ideological and Political Education in Curriculum” of Higher Vocational Majors. *Journal of Liaoning Higher Vocational Technical Institute*, 20(08): 53–55 + 61.
- [2] Zheng S, 2024, Research on the Construction of Ideological and Political Education in College English Courses in Higher Vocational Colleges – A Case Study of Puyang Vocational and Technical College. *Journal of Puyang Vocational and Technical College*, 37(05): 20–23.
- [3] Zhang W, 2023, Research on the Practice of Ideological and Political Education in College English Classes in Maritime Colleges – A Case Study of the Ideological and Political Education in College English Courses in Qingdao Ocean Shipping Mariners College. *Journal of Qingdao Ocean Shipping Mariners College*, 44(03): 77–82.
- [4] Cai X, 2022, Research on College English Course Ideological and Political Education as an Effective Approach to Ideological and Political Education in Vocational Colleges. *Campus English*, (02): 17–19.
- [5] Zhou F, Song L, Cheng L, et al., 2021, Exploration and Practice of Ideological and Political Education in the Construction of Online High-quality Biochemistry Courses in Medical Colleges and Universities. *Chemistry of Life*, 41(09): 2083–2087.
- [6] Wei Y, 2022, Research on the Ideological and Political Education Framework System of Civil Aviation-characteristic Physical Education Courses Based on the “One Body, Two Wings and Three Pivot Points” Model. *Journal of Chengdu Aeronautic Polytechnic*, 38(03): 6–10.
- [7] Li Y, Zhang Y, Li Y, et al., 2022, Exploration and Practice of Integrating Ideological and Political Education into Teaching Models – Taking the Course of “Medical Humanities and Practice” as an Example. *Chinese Medical*

Humanities, 8(11): 10–13.

- [8] Yin J, 2023, Inquiry into the Innovation of College English Education Models under the Information-based Background – A Review of “Research on the Innovation of College English Education Models”. *China Educational Journal*, (07): 155.
- [9] Su Y, 2023, Analysis of the Information-based Learning Paths of College English from the Perspective of Mobile Learning. *Modern Business Trade Industry*, 44(16): 72–74.
- [10] Liu H, 2022, An Investigation and Study on the Implementation of Online English Teaching in Private Colleges and Universities, thesis, Nanchang University.
- [11] Li Y, 2021, Teaching Optimization Design of College English Listening and Speaking Courses from the Perspective of the Integration of Information Technology and Curriculum, thesis, Shenyang Normal University.
- [12] Deng Y, 2014, Research on the Construction of Higher Vocational Public English Teaching Models Based on the Theory of Autonomous Learning, thesis, Guangxi Teachers Education University.
- [13] Miao X, Qian D, 2020, Reading of Cabin English Broadcast Words. Aviation Industry Press, Beijing.
- [14] Civil Aviation Administration of China Vocational Skills Appraisal Guidance Center, 2021, Civil Aviation Flight Attendant (2020 Edition). China Civil Aviation Publishing House Co., Ltd., Beijing.
- [15] Sun Q, 2023, Research on the Ideological and Political Construction Strategies and Implementation Paths of High-quality Online Open Courses for Cabin Crew Majors in Civil Aviation Colleges and Universities – Taking the Online Open Course of “Reading of Cabin Broadcast Words” as an Example. *Civil Aviation Journal*, 7(06): 153–156 + 42.

Publisher’s note

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

A Study on the Construction of Low-Carbon Campuses from the Perspective of Carbon Footprint

Na Cha¹, Saihana Jaesong^{1,2*}, Hailian Sun^{1,2}, Nabuqi¹

¹Inner Mongolia University of Science & Technology, Baotou Teachers' College, College of Ecology and Environment, Baotou 014031 Inner Mongolia, China

²National Carbon Accounting Center (Inner Mongolia) Baotou Branch Center, Baotou 014031, Inner Mongolia, China

**Author to whom correspondence should be addressed.*

Copyright: © 2025 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: In recent years, as global awareness of climate change and environmental protection continues to deepen, the concept of low-carbon green development has gradually evolved into a core guiding principle for advancing the sustainable development of society. As a vital component of the social system, campuses bear significant responsibility for addressing their own carbon emissions. From the perspective of carbon footprint, educational institutions must proactively shoulder their obligations and implement a suite of targeted, effective measures to construct low-carbon campuses. This endeavor not only enables a substantial reduction in campus carbon emissions but also plays a pivotal role in enhancing students' low-carbon awareness and fostering their environmental responsibility. Furthermore, through its demonstration effect, the construction of low-carbon campuses can drive the broader low-carbon transformation of society, thereby providing robust support for safeguarding long-term social sustainability. Against this backdrop, this paper first systematically elaborates on the multifaceted significance of building low-carbon campuses from the carbon footprint perspective, and subsequently proposes a set of actionable, context-adapted construction strategies. It is intended to offer valuable references and insights for researchers and practitioners engaged in related fields.

Keywords: Carbon footprint; Low-carbon campus; Building meaning

Online publication: November 14, 2025

1. The significance of building a low-carbon campus from the perspective of carbon footprint

1.1. It helps to directly reduce carbon emissions

During the campus process, energy conservation and environmental protection actions will be implemented in various aspects, such as waste disposal, energy use, etc., to reduce the carbon emissions of the school as a whole. For instance, we will vigorously promote the use of clean energy sources such as wind and solar power, and use them to replace traditional energy sources to improve the energy composition on campus, thereby reducing

carbon emissions resulting from excessive energy consumption. At the same time, schools should control the use of water resources rationally, install rainwater collectors, recycle water, etc., to avoid unnecessary waste of water resources and reduce carbon emissions from wastewater treatment. In addition, it is necessary to plan campus traffic rationally, increase pedestrian and bicycle paths, encourage staff to walk or ride bicycles and other low-carbon travel methods, and reduce the use of private cars and school buses, thereby effectively reducing carbon emissions from transportation. This will not only improve the quality of the campus environment and ensure the physical health of teachers and students, but also contribute to the sustainable development of our country ^[1].

1.2. It is conducive to cultivating students' awareness of low-carbon

Actively building a low-carbon system in the campus environment not only allows students to experience firsthand and deeply understand the crucial importance of a low-carbon lifestyle through low-carbon practices in daily life and a variety of educational activities. For example, schools can regularly hold various lectures, systematic courses and various forms of practical activities on the theme of low carbon, through which students can gain a comprehensive understanding of the far-reaching impact of carbon emissions on the natural environment and master effective knowledge and practical skills for energy conservation and emission reduction. This immersive learning experience not only helps to gradually cultivate students' sense of responsibility and mission for low carbon, but also effectively stimulates their enthusiasm for consciously practicing the concept of low carbon in their daily lives in the future, enabling them to gradually grow into firm advocates and active practitioners of low-carbon living. Through this educational model, students can not only develop good low-carbon living habits on campus, but also bring this concept into society and promote the development of the entire society towards low-carbon ^[2].

1.3. It is conducive to achieving a demonstration effect and policy promotion

In addition to being confined within the campus, the construction of a low-carbon campus can also have a positive radiating effect at the social level, attracting more members of society to participate and minimizing carbon emissions to the greatest extent. As one of the important components of the social system, schools, after promoting low-carbon emission reduction demonstrations and achieving success, can promote low-carbon lifestyles among the residents around the campus and the entire nation, encourage the entire society to actively practice the requirements of low-carbon emission reduction, and jointly build an environmentally friendly society. At the same time, the successful practices and practical experience of schools can also provide the government with scientific, practical, timely, and effective data for reference, ensuring that the policies formulated by the government are more operational and scientific, and creating a good situation throughout society that is both vigorously advocated and practical, promoting the process of sustainable development. In addition, through the multi-level, co-progressive low-carbon development path, it is conducive to forming a green and harmonious future-oriented society, thereby laying a solid foundation for achieving the sustainable development goals ^[3].

2. Strategies for building a low-carbon campus from the perspective of carbon footprint

2.1. Develop alternative energy sources rationally and apply renewable energy on a large scale

To build a low-carbon campus based on carbon footprint, it is particularly important to manage and apply green

and renewable energy scientifically. Schools can set up solar panels and install wind power generators, etc., to gradually replace traditional fuels and significantly reduce carbon emissions on campus. Among them, solar panels can convert the obtained solar energy into electricity to the greatest extent, and schools can rationally install wind turbines based on their own wind resources to generate clean electricity. In addition, schools can also advocate the use of alternative energy sources, such as biomass energy, geothermal energy from underground water sources, etc., scientifically adjust the campus energy structure to make the energy structure present a diversified feature and effectively improve the efficiency of campus energy utilization, laying a solid foundation for building a low-carbon campus. For example, schools can take effective measures to convert organic waste into biomass energy, or convert the underground heat sources of the school into geothermal energy. These renewable energy sources can all be used as energy sources for the school's long-term use ^[4].

This large-scale application of renewable energy not only helps to significantly reduce carbon emissions on campus, but also provides students with valuable opportunities to practice low-carbon technologies and cultivate their environmental awareness and innovation ability. Students can gain a deeper understanding and mastery of low-carbon technology by participating in the installation and maintenance of solar panels and wind power devices, experiencing the application process of renewable energy firsthand. At the same time, schools can further strengthen students' environmental awareness and innovation ability by conducting related courses and research projects, and cultivate more responsible and innovative talents for the future environmental cause. These talents will become an important force for promoting the low-carbon development of society and contribute to building a greener and more sustainable future ^[5].

2.2. Focus on optimizing the campus space and planning and designing an ecological campus

Schools should carry out green planning, increase the coverage of campus vegetation, increase the green area, the microclimate environment can be effectively improved, absorb carbon dioxide and release oxygen, and further reduce the low-carbon footprint. For example, planting herbaceous plants, shrubs and trees that are suitable for the local area on campus to form a multi-level greening system can not only green the campus but also enhance the ecological benefits as a whole ^[6].

Pay attention to the land-saving design of campus buildings, adopt energy-saving technologies and environmentally friendly materials, enhance the insulation and heat preservation capacity of buildings, and reduce energy consumption. For example, reduce the consumption of artificial light sources and air conditioning through natural light and natural ventilation designs. In addition, the rational use of advanced energy-saving lighting fixtures and air conditioning can also expand green Spaces and enhance the ecological value of buildings through vertical green walls, green roofs, etc. ^[7].

When schools scientifically plan their transportation systems, they should encourage low-carbon travel methods such as walking and cycling and reduce the use of motor vehicles. It is possible to encourage students and staff to choose low-carbon travel by setting up convenient walking and bike lanes, providing ample bike parking facilities, and promoting shared bikes. At the same time, rationally plan parking areas on campus, guide motor vehicles to park in an orderly manner, and reduce additional carbon emissions resulting from the search for parking spaces ^[8].

Schools should attach importance to rainwater collection and water resource recycling. By building rainwater collection systems, the collected rainwater can be used in non-potable areas such as road sprinkling and cleaning, campus greening, etc., reducing reliance on urban water supply networks. At the same time, schools

popularize and use water-saving equipment and facilities to fundamentally increase utilization and reduce the degree of water waste. This will not only cultivate students' awareness of water conservation and environmental protection, but also achieve the goal of building a green campus ^[9].

2.3. Implement low-carbon education and cultural cultivation, and correctly guide students' behavior

From the perspective of carbon footprint, schools should develop courses and training content related to low-carbon and environmental protection, implement the low-carbon concept in the teaching system of each major, and systematically cultivate students' low-carbon awareness on the basis of enhancing the cognitive effect of professional knowledge. For example, incorporate knowledge related to low-carbon economics, environmental science, and sustainable development into the curriculum, thereby guiding students to understand and grasp low-carbon knowledge from different levels and dimensions ^[10].

Schools should also actively organize various lectures and seminars on the theme of low-carbon, inviting renowned experts and scholars at home and abroad to share the latest research results and practical application experiences in the field of low-carbon, thereby effectively broadening students' academic horizons and stimulating their interest in low-carbon research. At the same time, schools can carry out a variety of low-carbon practical activities, such as garbage classification knowledge competitions, energy conservation and emission reduction creative design competitions, low-carbon life challenges, etc. Through these activities, students are encouraged to actively participate and experience the specific practices of low-carbon life in person, thereby developing good low-carbon behavior habits in practical operations ^[11].

Schools should make flexible use of various channels to promote low-carbon knowledge and its social significance to students, such as Weibo, wechat, Douyin, school websites, campus radio and bulletin boards, etc., to create a good low-carbon cultural atmosphere within the campus, and through these comprehensive and three-dimensional publicity and education methods, subtly guide students to develop low-carbon lifestyles and consumption patterns. Only in this way can the concept of low carbon be effectively permeated on campus and a favorable public opinion atmosphere be created for building ^{a low-carbon campus [12]}.

2.4. Vigorously apply emerging technologies to build a smart campus management system

The school uses Internet of Things technology to monitor in real time the actual consumption of waste, water and energy on campus, and installs smart sensing devices in dormitories, libraries and classrooms to accurately grasp the utilization of different resources, identify problems in the first place and deal with them when necessary, thereby improving the efficiency of resource utilization. Avoid unnecessary carbon dioxide emissions. In addition, schools use big data technology to assess carbon emissions, reasonably predict future trends, collect and integrate data on carbon emissions from different activity areas, build a complete database, and then use data analysis models to calculate carbon emission trends in subsequent periods, providing effective data support for schools to formulate reasonable carbon reduction plans ^[13]. Learn to accurately grasp the usage time, energy allocation, etc. of different buildings based on the data analysis results, and minimize energy waste to the greatest extent. In addition, the school fully leverages the advantages of artificial intelligence technology to enable automatic control of facilities on campus. Smart lights, for example, automatically adjust their brightness based on the light and the flow of people; Smart air conditioning systems will automatically adjust their operating status based on room temperature and the number of people, achieving the purpose of saving electricity resources. At the same time, artificial intelligence can also be used to control the flow of traffic on campus lanes and guide the orderly

passage of staff, vehicles, etc., thereby reducing the increase in vehicle exhaust emissions caused by traffic congestion ^[14].

In addition, schools build smart management platforms to integrate school data and services, providing more convenient and efficient services for staff and effectively enhancing their experience. For instance, staff members can use their mobile phones or campus cards to complete various services such as campus payment, entry and exit, and borrowing and returning of books, without the need for paper vouchers or card bodies, saving resources. Or, through an intelligent campus management system, provide personalized career advice to students to help them achieve true all-round development ^[15].

3. Conclusion

In conclusion, from the perspective of carbon footprint, the construction of a low-carbon campus is not only an environmental protection action with far-reaching significance, but also a key measure to promote sustainable development in the education sector and cultivate leaders of low-carbon living in the future society. For this, schools can develop alternative energy sources rationally and apply renewable energy on a large scale; Focus on optimizing campus space and planning and designing an eco-campus; Implement low-carbon education and cultural cultivation, and guide students' behavior correctly; Starting with strategies such as vigorously applying emerging technologies and building smart campus management systems can significantly reduce carbon emissions on campus, enhance the low-carbon awareness and environmental responsibility of teachers and students, improve the quality of the campus environment, safeguard the physical health of teachers and students, and promote the development of the whole society towards low-carbon through demonstration effects and policy promotion. In the future, with the continuous advancement of technology and the deepening of concepts, low-carbon campuses will become the new normal in the field of education, laying a solid foundation for building a green, harmonious and sustainable future society.

Funding

University General Project. "Investigation on Diversity and Distribution of Woody Plant Communities in Jiufeng Mountain, Baotou City" (Project No.: BSYKJ2023-ZY03)

Disclosure statement

The author declares no conflict of interest.

References

- [1] Li B, Zhang W, Han Z, et al., 2024, Research on the Path of Low-Carbon Campus Construction in Colleges and Universities Based on Questionnaire Survey: A Case Study of Northwestern Polytechnical University. *Energy Conservation*, 43(9): 82–86.
- [2] Wen D, Wei L, 2024, Low-Carbon Layout Optimization Strategies for University Campuses from the Perspective of Carbon Footprint: A Case Study of Xuzhou Institute of Technology. *Journal of Xuzhou Engineering College (Social Science Edition)*, 33(5): 100–108.

- [3] Cai X, Meng F, Sun Y, et al., 2025, Carbon Footprint Accounting in University Campuses and Path Analysis of Zero-Carbon Campus Planning: A Case Study of Haidian Campus of Beijing Normal University. *Journal of Beijing Normal University (Natural Science Edition)*, 61(2): 170–177.
- [4] Gao H, 2024, Research on the Application of “Photovoltaic Storage Direct Flexible” Technology in the Design of Low-Carbon Campus Buildings. *China Building Decoration and Renovation*, 2024(15): 92–94.
- [5] Chen W, Li H, et al., 2024, Based on the Investigation and Analysis of Energy Consumption Behavior in Colleges and Universities to Facilitate the Construction of Low-Carbon Campuses: A Case Study of Wuxi University. *Environmental Education*, 2024(5): 50–53.
- [6] Cheng Z, Zhong X, 2024, Practicing Low-Carbon and Environmental Protection, Creating a Green Home: A Record of Low-Carbon Campus Construction at Guangzhou Light Industry Technician College. *Environmental Education*, 2024(Z1): 142.
- [7] Liu Q, 2023, Research on Low-Carbon Evaluation and Optimization Strategies for University Campuses Based on Carbon Footprint Accounting, thesis, Southeast University.
- [8] Zhang J, 2023, Research on Low-Carbon Optimization Design of University Campus Living Areas Based on Carbon Footprint Analysis, thesis, Shenzhen University.
- [9] Xie X, Zeng Y, He S, et al., 2023, A New Exploration of the Whole-Process Management Path for Green and Low-Carbon Campus Construction in Higher Education Institutions under the “3060 Carbon Goals”. *Green Building*, 15(3): 5–7 + 20.
- [10] Deng Y, 2021, Research on Low-Carbon Campus Planning Strategies Based on Student Energy Behavior Analysis, thesis, Southwest University of Science and Technology.
- [11] Li S, Ju K, Liu Z, 2022, The Application of Top-Level Design in the Construction of Smart Low-Carbon Campus. *Intelligent Building Electrical Technology*, 16(3): 61–63.
- [12] Li P, Cui P, 2022, Research on the Construction Path of Low-Carbon Campus in Chinese Universities. *Resources Conservation and Environmental Protection*, 2022(1): 146–148.
- [13] Wang Q, Qiu Q, 2020, Research on Low-Carbon Campus Construction in Colleges and Universities. *Modernization of Education*, 7(13): 94–95 + 100.
- [14] Bao L, 2019, Research on the Construction of Low-Carbon Campus Parks in Colleges and Universities in Jilin City. *Southern Agricultural Machinery*, 50(16): 37.
- [15] Dai K, Li X, Chen X, et al., 2019, Low-Carbon Campus Research and Improvement Strategies: A Case Study of Hefei University of Technology (Tunxi Road Campus). *Anhui Architecture*, 26(6): 145–147.

Publisher's note

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

An Empirical Study on the Digital Literacy Level of College Students in Applied Universities Based on Situational Learning Theory

Qiaoxia Wang^{1,2}, Fangdan Liu^{2*}

¹Central China Normal University, Wuhan 430079, Hubei, China

²Wuchang Institute of Technology, Wuhan 430065, Hubei, China

**Author to whom correspondence should be addressed.*

Copyright: © 2025 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: To explore the influencing factors and improvement paths of digital literacy among college students in application-oriented universities, this paper constructs a digital literacy evaluation framework based on the theory of situational learning and conducts a survey of 7,905 students in application-oriented universities. An exploratory factor analysis using SPSS 30 revealed characteristics such as contextualized stratification and significant disciplinary differences in students' digital literacy. Finally, implications were drawn from aspects such as improving lifelong learning services, creating interactive learning scenarios, establishing precise training mechanisms, and building school-enterprise practice communities.

Keywords: Situated learning theory; Digital talent; Digital literacy; Applied universities; Factor analysis

Online publication: November 14, 2025

1. Introduction

Situated learning theory, an important learning theory co-proposed by Lave J and Wenger E, emphasizes that individual learning is a process of gradually integrating from “legitimate marginal participation” into “community of practice,” and stresses that “de-contextualized knowledge is fragile” ^[1]. As a core reserve force for the future digital economy and social innovation, the cultivation of digital literacy among college students is not only a basic ability requirement for individuals to adapt to the digital age, but also a key link for the country to implement the strategy of building a digital talent power and seize the commanding heights of global digital competition. The Outline of the Plan for Building a Strong Education Nation (2024–2035) explicitly puts forward the strategic deployment of “building a learning society and opening up new development tracks and shaping new development advantages through digitalization of education” ^[2], elevating the cultivation of digital literacy to the core issue of national education development. From a global perspective, digital literacy has become a consensus goal for talent cultivation in the international community, but there are still differences in the definition of its connotation and the use of the concept among countries and international organizations. The UNESCO

Global Framework on Digital Literacy, released in 2018, covers seven major areas including hardware and software foundations, information and data literacy, communication and collaboration, digital content creation, security protection, problem-solving, and career-related skills, which are detailed into 26 specific indicators^[3].

In China, the “Action Plan for Improving Digital Literacy and Skills for All” defines digital literacy as “the collection of qualities and abilities that citizens in the digital society should have for learning, working and living in terms of digital access, production, use, evaluation, interaction, sharing, innovation, security and ethics”^[4], providing a macro framework for the cultivation of local digital literacy. In addition, in the “Survey Report on the Development Level of Digital Literacy and Skills of the Entire Population (2024)” released by the Cyberspace Administration of China, the survey content of digital literacy and skills of the entire population mainly includes the status of digital literacy and skills, participation in digital activities and demographic characteristics of respondents, and its core indicators cover digital cognition, digital skills and digital thinking^[5]. This also provides a useful reference for the assessment of digital literacy. Based on the Global Framework of Digital Literacy, this paper designs a digital literacy level assessment scale that includes the core elements of situational learning, and analyzes the overall level of digital literacy and related influencing factors of college students in application-oriented universities based on the results of the questionnaire survey, providing data support and decision-making reference for exploring the path to improving the digital literacy of college students in application-oriented universities.

2. Research design

2.1. Sample design

The study used Wenjuanxing to collect data from college students in applied universities in Hubei Province. The survey was conducted in December 2024, and 7,905 valid questionnaires were collected. The questionnaire was designed with 41 items, including 4 items of basic sample information and 36 items of core variables, all of which were multiple-choice questions. For the convenience of subsequent analysis, all the contents of the questions were represented by variable codes. Among the samples, 52.2% were male and 47.8% were female; Freshmen, sophomores, juniors and seniors accounted for 33%, 26%, 26% and 15% respectively; 77.2% of students have participated in digital literacy education activities, and 22.8% have not. Engineering students accounted for 42.7%, art students accounted for 15.3%, and students in the four disciplines of literature, economics, management, and education accounted for 42%.

2.2. Research tools

To facilitate students’ self-assessment of their digital literacy level, all core variable questions in the questionnaire were scored using the Likert five-point scale (marked as 5, 4, 3, 2, and 1, respectively)^[6], and the higher the score, the higher the level of digital literacy. Using the software tool SPSS 30, an exploratory factor analysis was conducted on the questionnaire^[7]. After eliminating items with confusing correspondence between individual questions and factors, 33 core questions were retained and those belonging to the same factor explanation were grouped together.

2.3. Reliability and validity analysis

The study used Cronbach’s Alpha coefficient as the criterion for reliability testing. The Cronbach’s Alpha values for the reliability of the 33 variables in the scale were all greater than 0.9, and the overall reliability of the 33 items, as measured by Cronbach’s Alpha, was 0.989, which exceeds 0.9. It can be seen that the reliability of the study sample is very good. The study used KMO and Bartlett’s sphericity tests as validity criteria. The KMO value was 0.986,

greater than 0.7, and the P value corresponding to the Bartlett's sphericity test was less than 0.001. The cumulative variance interpretation rate of the five explored factors was 86.831%, indicating good structural validity. According to the rotating component matrix, the correspondence between the five factors explored (represented by YZ1 for understanding digital technology, YZ2 for accessing digital resources, YZ3 for creating digital content, YZ4 for digital ethics and security, and YZ5 for self-learning using digital tools) and the question was consistent with the expected results. The minimum factor loading coefficient value of the corresponding question is 0.530 and the maximum is 0.777, indicating a good correspondence between the question and the factor and a high level of validity.

3. Research results and analysis

3.1. Analysis of the overall level of digital literacy

In terms of descriptive statistics, the overall average score of digital literacy is 3.907, with a standard deviation of 0.727, and it follows a normal distribution. The scores of the five factors, from low to high, are as follows: Digital technology cognition (YZ1) with an average score of 3.758, digital content creation (YZ3) with an average score of 3.839, access to digital resources (YZ2) with an average score of 3.926, self-directed learning using digital tools (YZ5) with an average score of 3.930, and digital ethics and security (YZ4) with an average score of 4.043. From this, it can be seen that the highest score was in digital ethics and security, which is largely consistent with the research conclusions of Liang et al. ^[8], Wu et al. ^[9], indicating that college students in applied universities not only have a high self-assessment in digital ethics and security, but also have clear thinking and judgment, and have a high level of digital security and ethical literacy. In contrast, the self-assessment scores of digital technology cognition and digital content creation were both lower than the total average, indicating that although students in applied universities scored relatively high in self-study using digital tools, their understanding of digital technology was still vague and their ability to create content using digital thinking was relatively weak.

3.2. Analysis of the impact of basic information grouping on digital literacy levels

To investigate whether the basic information grouping of college students in application-oriented universities made significant differences in the overall level of digital literacy, we further conducted independent sample t-tests or single-factor ANOVA tests and found that all five basic information items made significant differences in the overall level of digital literacy. The average score of digital literacy for male college students was 3.980, slightly higher than the average score of 3.826 for female college students, which is consistent ^[10] with the conclusion of Sun Shaowei's research. Senior students had the highest average digital literacy score at 3.953, while freshmen had the lowest at 3.859. Engineering students had the highest average digital literacy score of 3.989, significantly higher than students in other disciplines. This is closely related to the fact that engineering students in applied universities use digital tools more frequently in classroom activities and subject competitions. Students who participated in digital literacy education activities scored an average of 3.990, while those who did not scored only 3.623. Moreover, college students who participated in digital literacy education activities not only scored significantly higher overall than those who did not, but also scored significantly higher in all five factors than those who did not.

3.3. Correlation analysis of core variables with digital literacy levels

To investigate whether there is a correlation among the variables, we used the Pearson Correlation coefficient for analysis, and the results are shown in **Table 1**. The five factors were respectively significant at the 0.01 level with the average score of digital literacy, and the correlation values were in the range of 0.880 to 0.961, indicating that all

five factors were significantly positively correlated with the average score of digital literacy and had a relatively close correlation with it. Among them, self-directed learning using digital tools (YZ5) has the highest correlation coefficient with average digital literacy at 0.961, and is significantly positively correlated ($p < 0.001$). At the same time, there is also a general positive correlation among the five factors, indicating that there is a close connection among them.

Table 1. Results of correlation analysis

| Digital literacy scores | | YZ1 | YZ2 | YZ3 | YZ4 | YZ5 |
|-------------------------|---------------------------|---------|---------|---------|---------|---------|
| Digital literacy score | Pearson correlation | -- | | | | |
| YZ1 | Pearson correlation | 0.880** | -- | | | |
| | Significance (two-tailed) | < 0.001 | | | | |
| YZ2 | Pearson correlation | 0.933** | 0.830** | -- | | |
| | Significance (two-tailed) | < 0.001 | < 0.001 | | | |
| YZ3 | Pearson correlation | 0.933** | 0.824** | 0.850** | -- | |
| | Significance (two-tailed) | < 0.001 | < 0.001 | < 0.001 | | |
| YZ4 | Pearson correlation | 0.892** | 0.683** | 0.787** | 0.782** | -- |
| | Significance (two-tailed) | < 0.001 | < 0.001 | < 0.001 | < 0.001 | |
| YZ5 | Pearson correlation | 0.961** | 0.777** | 0.840** | 0.871** | 0.862** |
| | Significance (two-tailed) | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 |

Note: ** indicates a significant correlation at level 0.01 (two-tailed).

3.4. Multiple linear regression analysis between core variables

Assuming YZ5 is the dependent variable and YZ1-YZ4 is the independent variable, the results of the multiple linear regression analysis are shown in **Table 2**. The adjusted R^2 was 0.852, indicating that the four variables YZ1-YZ4 could account for 85.2% of the changes in autonomous learning using digital tools (YZ5), and the model fit was very good. The P values of the four variables YZ1-YZ4 were all less than 0.001, showing significance, and the corresponding regression coefficients B values were 0.074, 0.142, 0.353, and 0.399, all greater than 0. It can be seen that the stronger a college student's sense of identification with digital technology, the more willing they are to use digital platforms in an active way to obtain the necessary resources, the more willing they are to spend time creating digital content, and the better they know how to use digital tools for self-study, which is almost consistent with Joanna Goode's research conclusion ^[11].

Table 2. Result of multiple linear regression analysis

| Model | Unstandardized coefficients | | Standardized coefficient | t | P | R ² | Adjusted R ² | Error in standard estimates |
|------------|-----------------------------|----------------|--------------------------|--------|---------|----------------|-------------------------|-----------------------------|
| | B | Standard error | Beta | | | | | |
| (Constant) | 0.128 | 0.018 | | 6.992 | < 0.001 | 0.853 | 0.852 | 0.295 |
| YZ1 | 0.074 | 0.008 | 0.078 | 9.256 | < 0.001 | | | |
| YZ2 | 0.142 | 0.010 | 0.142 | 14.556 | < 0.001 | | | |
| YZ3 | 0.353 | 0.009 | 0.363 | 38.064 | < 0.001 | | | |
| YZ4 | 0.399 | 0.007 | 0.413 | 55.208 | < 0.001 | | | |

a. Dependent variable: YZ5 b. Predictor variable: YZ1-YZ4

4. Research implications

4.1. Improve lifelong learning services to cultivate digital talents

College students are the main force for participating in digital work and digital innovation in the future and should have the lifelong learning ability and adaptability necessary for the digital age^[12]. In the context of rapid technological iteration, traditional school education can no longer fully meet the demands of social development, and lifelong learning has changed from an individual choice to a necessity for growth. From an international perspective, in April 2025, the European Commission released the AI Continent Action Plan, which identified AI skills and talent as one of the five key areas and launched a series of major initiatives aimed at cultivating digital talent^[13], particularly the launch of the one-stop service platform - the AI Skills Academy. In light of China's current situation, ubiquitous and accessible lifelong learning services can be provided through social educational institutions such as university libraries at all levels, public libraries, and cultural centers in various regions. Create always-online classrooms through intelligent learning spaces, provide high-level public services for lifelong learning, and support the realization of a learning society where everyone can learn, everywhere can learn, and anytime can learn.

4.2. Create interactive learning scenarios with digital courses at the core

Courses are the medium for developing digital literacy, and how to integrate digital literacy into courses is the key to cultivating digital talents^[14]. The digital literacy and ability development system for students in China has not yet been formed and is rather scattered among different course contents, lacking coherence, progressiveness, relevance, and connection in the design of course contents at different stages^[15]. Digital curriculum is a form of curriculum that aims to cultivate innovative talents, embody digital intelligence empowerment thinking, organize and represent teaching content using digital^[16], networked and intelligent technologies, conduct scenario-based teaching activities with value guidance, outcome orientation, and problem-solving, and record the teaching process and conduct evidence-based evaluation of the effect. Teachers, relying on high-quality digital course resources on the national Smart education platform, create interactive learning scenarios among teachers and students, among students, and among students, and use AI tools to analyze students' learning situations in real time.

4.3. Use digital evaluation as a means to establish a precise training mechanism

College students in the 21st century have grown up in an environment where digital technology is highly prevalent. They have been exposed to tools and toys of the digital age, such as the Internet, smartphones, and video games, since their childhood, and thus have a natural adaptability and intuitive understanding of the digital environment. The development of students' digital literacy and ability requires the joint efforts of schools, students, and teachers. Schools should incorporate digital literacy into the education evaluation system, establish a "regular monitoring + precise training" working mechanism for students' digital literacy level, and at the same time strengthen the training of teachers' digital technology application and ability, using curriculum reform as a lever, driving the innovation of methods and models, technical support, curriculum systems and forms of digital teaching for college teachers, and comprehensively boost the improvement of digital literacy for college teachers.

4.4. Build a school-enterprise practice community with digital technology as the link

Schools and enterprises jointly offer virtual simulation courses, using virtual devices to simulate real-world physical space equipment to meet the practical training needs of students of different majors, and invite enterprise

technical experts and university teachers to teach digital + professional courses, bringing the real digital scenarios of enterprises into the classroom to build a practice community of “enterprise mentor teaching + real project practice”, guiding students to understand digital technology, use digital devices, experience digital services through multimodal experiences such as VR and AR, organize group discussions, lead students to participate in social practices, subject competitions, innovation and entrepreneurship competitions and other activities of enterprises and industry organizations, and enable students to learn by doing and understand by learning, so as to strengthen students’ digital thinking and enhance their digital creation ability.

Funding

Hubei Provincial Education Science Planning Project, “Practice and Exploration of Information Technology Empowering Curriculum Teaching Evaluation” (Project No.: 2023BG151)

Disclosure statement

The authors declare no conflict of interest.

References

- [1] Lave J, Wenger E, 1991, *Situated Learning: Legitimate Peripheral Participation*. Cambridge University Press, London.
- [2] The Central Committee of the Communist Party of China, The State Council, 2025, *The Outline of the Plan for Building a Strong Education Nation (2024–2035)*. People’s Daily, January 20, 2025.
- [3] Antoninis M, Montoya S, 2018, *A Global Framework to Measure Digital Literacy*. UNESCO, visited on July 1, 2025, <https://uis.unesco.org/en/blog/global-framework-measure-digital-literacy>.
- [4] Central Cyberspace Affairs Commission, 2021, *Action Plan for Improving Digital Literacy and Skills for All*. CAC, visited on July 1, 2025, http://www.cac.gov.cn/2021-11/05/c_1637708867754305.htm.
- [5] National Survey and Research Group on the Development of Digital Literacy and Skills for All, 2024, *Universal Digital Literacy and Skills Development Level Survey (2024)*. The State Council of the People’s Republic of China, visited July 1, 2025, https://www.gov.cn/lianbo/bumen/202410/content_6983266.htm.
- [6] Likert R, 1932, *A Technique for the Measurement of Attitudes*. *Archives of Psychology*, 1932(140): 1–55.
- [7] Spearman C, 1904, *General Intelligence Objectively Determined and Measured*. *American Journal of Psychology*, 15(1): 201–292.
- [8] Liang Q, Wu H, Sha X, et al., 2025, *The Current Situation, Problems and Countermeasures of Digital Literacy Among Chinese College Students: Based on Sample Data of 29,425 Students Nationwide*. *Audio-Visual Education Research*, 2025(4): 73–85.
- [9] Wu D, Sun X, Liang S, et al., 2025, *Construction of AI Literacy Evaluation System for College Students and an Empirical Study at Wuhan University*. *Frontiers of Digital Education*, 2(1): 6–6.
- [10] Sun S, 2024, *Research on Digital Literacy of College Students*. *Library Construction*, 2024(3): 127–138 + 149.
- [11] Goode J, 2010, *Mind the Gap: The Digital Dimension of College Access*. *The Journal of Higher Education*, 81(5): 583–618.
- [12] Xiao P, Zhao Q, 2021, *The Path to a Strong Digital Talent Nation: The Action Plan for Enhancing Digital Literacy*

- and Skills of the Entire Population and the Digital Literacy Education Strategy for College Students. *Journal of Agricultural Library and Information Science*, 33(12): 6–15.
- [13] European Union (EU), 2025, AI Continent Action Plan. European Commission, visited July 1, 2025, <https://eur-lex.europa.eu/legal-content/EN/TXT/uri=CELEX:52025DC0165>.
- [14] Liu B, Cen Y, 2023, Promoting Digital Talent Development with a Digital Literacy Framework. *China Education Daily*, February 27, 2023.
- [15] Wu D, Zhu S, Wang M, 2022, Integrated Construction of Student Digital Literacy Development System: Challenges, Principles and Approaches. *China Educational Technology*, 2022(7): 43–49.
- [16] Xie Y, Li C, Li C, et al., 2024, Digital Curriculum in Colleges and Universities in the Intelligent Age: Connotation, Form and Construction. *Research on Educational Technology*, 2024(11): 5–12.

Publisher's note

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

Developing High-Quality Forensic Medicine Talent through Teaching Reform in China

Hai Wu, Yadong Guo, Yang Xia, Chengxin Ye, Yanjie Shang*

Department of Forensic Science, Xiangya School of Basic Medical Sciences, Central South University, Changsha 410013, Hunan, China

**Author to whom correspondence should be addressed.*

Copyright: © 2025 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: With the introduction of the new medical education concept in China, traditional forensic medicine education faces challenges such as a disconnect between theory and practice, lack of student engagement, and inadequate ideological education. This paper analyzes the “dual-track” teaching model based on Outcome-Based Education (OBE), incorporating Case-Based Learning (CBL) and Team-Based Learning (TBL) within the new medical education framework. It also integrates blended online and offline teaching, develops an online resource platform for forensic courses, and consolidates various teaching and internship resources to create an offline teaching platform. The aim is to enhance students’ self-directed learning, practical skills, and professional competencies. The requirements for cultivating medical talents in this context are comprehensive and diverse, stressing the integration of ideological elements throughout the teaching process to nurture high-level forensic professionals with solid knowledge, ethical standards, innovative capabilities, and a global perspective.

Keywords: New Medical Education; Forensic Medicine; Outcome-Based Education (OBE); Teaching Theory Innovation

Online publication: November 14, 2025

1. Introduction

In August 2018, the central government and the State Council jointly issued the Opinions of the Ministry of Education on Accelerating the Construction of High-level Undergraduate Education and Comprehensively Improving Talent Cultivation Capability, in which the concept of “new medical science” was formally proposed for the first time. In the same year, the Ministry of Education and other three ministries and commissions jointly issued the Opinions on Strengthening Medical Education Collaboration and Implementing Excellence in Physician Education and Training Program 2.0, which comprehensively deploys the construction of the new medical science and emphasizes the need for medical education to take the initiative to adapt to the new requirements, to promote reforms through innovation, to promote the development of reforms, and to devote itself to cultivating a large number of outstanding medical talents ^[1].

Forensic medicine its research object is mainly for the human body and the human body related substances

detection, crime scene investigation, etc., although the discipline is categorized under the medical category, but it belongs to the legislation, the judiciary and other social management matters to provide forensic scientific and technological evidence of forensic medicine, rather than prevention, treatment and other diagnosis and treatment of medical disciplines ^[2]. It covers a wide range of areas, and as an independent medical discipline has its own unique research object, research purpose, and problems to be solved. Although the new medical science is concerned about the reform of all types of advanced medical personnel training modes, due to the existence of certain differences between forensic science and traditional medicine, this new concept for forensic science majors still lacks a certain degree of relevance and operability ^[3]. In the context of the new medical science, it is necessary to explore the innovation of forensic science teaching theory for the unique characteristics of the forensic science specialty and students' needs, and it is necessary to promote the reform of forensic science teaching from the existing problems and challenges.

2. Existing problems and innovative ideas in forensic medicine education

The curriculum of the undergraduate forensic training program covers mathematics, science, and chemistry, basic medicine, clinical medicine, and forensic professional core courses, aiming to help professional integration through the accumulation of fundamentals. However, students have a vague concept of forensic science in the early stage, and it is difficult for them to use the medical courses in forensic science practice, even though they learn well. This problem has existed for a long time in the teaching of forensic medicine, and currently, through the adjustment of the program will be an introduction to forensic medicine, forensic toxicology analysis, and other core courses in advance and cross-studied with the medical courses, to help students grasp the key points of forensic medicine early and combined with practice, and achieved certain results. However, at present, the medical curriculum is still dominated by medical courses, and students are more concerned about the medical focus, ignoring the content of forensic practice, and there is a lack of solid professional knowledge, a weak sense of self-study, and a low degree of professional identity. At the same time, the teacher training awareness to be improved, the lack of the "student-centered" concept, a single teaching method, and low acceptance of new methods, making it difficult to implement the whole process ^[4].

In recent years, the traditional "heavy theory light experiment" idea changed, with forensic forensics and other courses increasing the experimental hours, but the experimental class still exists, with the theory accounting for too heavy, and students' hands-on operation of the problem of less hours. Medical school teaching evaluation is still based on the memory mode assessment, resulting in students thinking, a high forgetting rate is not conducive to the cultivation of complex, innovative medical talents.

In view of the problems of disconnecting theory and practice, lack of students' interest in learning, and insufficient civic education in forensic medicine teaching, under the background of the new medical science, we have deeply implemented the concept of "three-whole-education", and integrated the civic elements into the whole process of forensic medicine teaching. Through the "dual-track" teaching mode of CBL and TBL based on the concept of OBE, combined with online and offline blended teaching, we have constructed a teaching resource platform for online forensic science courses, integrated teaching and internship resources, improved students' independent learning, practical ability and professionalism, and cultivated high-level forensic science majors with solid professional knowledge, noble professional ethics, innovative ability and international vision. international vision, and cultivate high-level forensic science professionals with solid professional knowledge, noble professional ethics, innovative ability, and international vision.

3. Theoretical basis and innovative solutions

3.1. Integrating ideological and political education into the curriculum to promote comprehensive education

After graduation, most of the forensic science students enter the public prosecution system, colleges and universities or forensic identification centers, and their work is crucial to the judicial system. The traditional teaching of forensic medicine focuses more on theoretical teaching, and sometimes the comprehensive quality cultivation of students is neglected, which will lead to a certain extent to the separation of the ideological and moral quality of students from the requirements of their work ^[5]. The Guidelines for the Construction of Civics and Politics in the Curriculum of Higher Education Institutions point out that colleges and universities need to integrate the education of ideology and politics into each curriculum, and cultivate socialist builders and successors who are all-rounded in morality, intelligence, physical fitness, and aesthetics ^[6]. In forensic science, Civic and political elements such as awareness of the rule of law and ethical thinking should be explored and integrated into teaching ^[7]. Xi'an Jiaotong University School of Forensic Science ^[8] emphasizes the importance of the preparation of the course Civics and Politics case base, through the combination of professional characteristics of the material, so that the professional course cases are more educational.

Forensic science as a comprehensive practice discipline, the content of education in addition to professional knowledge and skills, pay more attention to the comprehensive quality of students, especially ideological and political education. Teachers need to pay attention to students' thoughts and values when imparting knowledge, and guide them to establish the correct three views. Ideological and political education should be carried out throughout the entire learning process of students, through the curriculum design and choice of teaching methods, to cultivate students' sense of social responsibility and other qualities in professional learning. For example, case studies are integrated into courses such as forensic pathology to emphasize the importance of law and ethics, and to realize the combination of explicit and implicit education to build an all-round pattern of education.

3.2. Blended “Dual-Line” teaching: Online and offline integration

Forensic science, as an applied discipline with extensive knowledge, has limited offline resources and an inefficient organization. Online teaching can solve the location and resource limitations, but the practice content needs offline interaction for efficient cultivation. Combining the characteristics and job requirements of forensic science, we build an online course platform, integrate internship resources, and promote online-offline hybrid teaching under the concept of OBE in order to enhance students' theoretical application and technical practice ability.

3.2.1. Build a teaching resource platform for online forensic science courses

Forensic science is a multidisciplinary fusion, and its teaching resources are huge; and students often encounter problems such as a lack of information and time-consuming searches. In this regard, an online platform for forensic science can be set up, with resources covering three aspects: teaching subjects, experimental teaching, and extracurricular learning. The resources for teaching subjects include textbooks, courseware, and exercises; the resources for experimental teaching include experimental textbooks, videos, and virtual simulation experiments; and the resources for extracurricular learning include scientific research and reading materials. The platform is open to teachers and students in stages and modules, opening modules according to the teaching stage, and opening higher permissions for the whole stage of learning content for easy access. Setting up different learning boards, students pre-study marking doubts, teachers answer in class, cultivate independent

learning ability, and enhance the teaching effect. Virtual simulation technology is gradually maturing in medical education, which provides experimental scenarios through modeling, and students' human-computer interaction and operation, combined with the experimental process training, helps students understand the experimental principles and operations, and improves their practical ability, but at present, there are problems such as low coverage of experiments and poor stability of the platform. The online assessment board facilitates teachers to test the learning effect of students promptly, which should be combined with real cases to promote in-depth analysis of students, and assess students' mastery and adjust the teaching and learning programs through mutual assessment of students and teachers' comments ^[9].

The academic tutoring system has been widely tried in China's colleges and universities, with remarkable results, but problems such as weak teacher-student interactions have emerged in its implementation ^[10]. The online platform interactive board can be based on the academic tutoring system to develop teacher-student interaction, student questions into the usual grades, set anonymous questions and answers to enhance student initiative and trust. Mentor real-name question and answer system, set up a guidance team to solve the problem, the question and answer situation into the teacher assessment, to improve the enthusiasm of mentor participation.

3.2.2. Integrate multi-party teaching internship resources and build an offline teaching platform

Online teaching is flexible and has diverse resources, but lacks face-to-face communication, requires high self-discipline for students, and is easily affected by network equipment, which is not conducive to ideological education and practical simulation. The details of forensic work are crucial, and it is difficult to simulate actual case processing by online resources alone. Offline teaching can promote teacher-student interaction, enhance the emotional connection, and the public prosecutors and law departments, forensic science centers, and other practical platforms provided by the public prosecutors and law enforcement departments, can allow students to participate in real prosecution cases, to enhance their practical ability and professionalism.

Online and offline "dual-line" teaching combines the advantages of both, building an online resource platform and an offline teaching system. "Dual-line" courses have a wealth of resources as well as flexibility and convenience, etc., to meet the students' personalized learning, giving full play to the students' initiative, interactive, and engaging. Initiative, at the same time, the enhancement of interactivity and openness stimulates the creativity of teachers, constantly deepens the course content, improves the completeness of the course, and makes the forensic science course full and rich in connotation, full of attraction ^[11].

3.3. CBL and TBL "dual-track" teaching under the concept of OBE

Forensic science, as a highly practical application discipline, its teaching and training objectives strictly implements the training mode of theory and practice. However, the traditional teaching method focuses on the teacher's lecture and the students' passive understanding and acceptance, which leads to poor learning initiative and is not conducive to the cultivation of thinking ability, working ability, and innovation ability. This filler education mode cannot help students combine theory and practice well, resulting in poor learning motivation and unsatisfactory teaching effect. It mainly centers around lecturers and ignores the students' main position ^[12].

OBE (Outcome-based education) education concept is the education model advocated by American scholar Spady, which is oriented to the actual output of results, emphasizing student-centeredness and highlighting the subjectivity of students. Under the concept of OBE, the teaching program setting, implementation, and evaluation mode are all from the perspective of students. Teachers clearly understand the abilities and skills that students

need to have, and design the curriculum system and evaluation methods in a targeted manner to ensure that students achieve the expected learning results^[13].

CBL (Case-Based Learning) combines forensic science cases, explores the key points of the course, sets related problems, or extends the knowledge content, and organizes student discussions. Forensic science cases are mostly from real life, such as Simpson's wife murder case, Zhu Ling case, Fudan poisoning case, and other major social impact cases, as well as public security departments and identification centers' actual cases. The selection of cases should take into account the teaching objectives, content requirements to ensure that they are classic, profound, and representative. Real cases can stimulate students' interest in learning, and teachers guide students to think about the forensic knowledge and skills involved, encourage students to use basic theoretical knowledge to analyze and discuss, and consult relevant literature, so as to consolidate knowledge and enhance practical thinking. cooperative teaching method. It takes students as the main body and focuses on improving students' independent learning ability and lifelong learning quality^[14]. The concept of TBL is a combination of goal guidance and team discussion, and students are categorized according to their cognitive level and learning goals to form learning teams. Students can discuss and communicate with each other as a team to complete the task together and form complementary strengths. For example, in the case analysis, teamwork and clear division of labor improve the details of the case, to obtain the correct results, to stimulate the enthusiasm of students, strengthen the collision of ideas, exercise teamwork and critical thinking ability. Teachers can carry out various forms of teaching activities through learning teams, such as pre-study preparation, flipped classroom, team debriefing, and teaching assessment.

CBL and TBL have their own advantages and disadvantages. The "dual-track" teaching method, which integrates the two, has been used in many medical disciplines with good results. Introducing real forensic cases stimulates students' interest and cultivates forensic thinking. Teamwork promotes interactive exchanges and enhances communication, collaboration and problem-solving skills. These two methods emphasize the connection of theory to practice, promote students' independent learning, in-depth understanding of the application of knowledge, help students learn and improve from their mistakes, and focus on both academic achievement and comprehensive quality training, which is significant for personal development and future career^[15].

4. Evaluation of teaching effectiveness

Student-centered, through the "online + offline" multi-form, "teachers + students + internship base" diversified evaluation strategy, to build a "formative + diagnostic + summative" evaluation system. Formative evaluation is a dynamic assessment system.

Formative evaluation is a dynamic evaluation system that improves teaching and pays attention to the whole process of students' development through continuous feedback. Adopting the diversified subjects of "teachers + students + internship bases" and combining various methods, the assessment is comprehensive in three dimensions: knowledge and skills, classroom behavior and emotional value. Teachers observe students' performance in skills operation and thematic discussion, and dynamically track the growth of their abilities by combining teamwork, participation and other affective attitudes; students strengthen reflection through self-evaluation and peer assessment. The evaluation of internship bases focuses on practical ability to ensure the connection between theory and practice. Diagnostic evaluation quantitatively analyzes students' knowledge base and thinking level before and after teaching through online and offline scales and interviews, providing a basis for teaching adjustments; summative evaluation integrates formative and diagnostic data, combines with

examination results, and quantitatively evaluates the effectiveness of comprehensive education of “knowledge + ability + value,” realizing the closed-loop optimization of the evaluation system. Optimization.

5. Conclusion

As a cross-cutting and applied discipline, forensic science plays an important role in the fields of forensic identification and crime investigation. With the continuous development of science and technology and the continuous improvement of the rule of law, forensic science education will usher in a new opportunity for development, and by deepening the reform of forensic science teaching, we will cultivate more high-quality and high-level forensic science talents, and make greater contributions to the maintenance of social justice and the construction of rule of law in China.

Funding

Postgraduate Education and Teaching Reform Research Project of Central South University (Project No.: 2025JGB164); Education and Teaching Reform Research Project of Central South University (Project No.: 2025jy052)

Disclosure statement

The author declares no conflict of interest.

References

- [1] Ministry of Education, National Board of Health, State Administration of Traditional Chinese Medicine, 2018, Suggestions on Strengthening the Cooperation Between Doctors and Teachers in Implementing the Excellent Doctor Education Plan 2.0, visited on October 30, 2024, https://www.gov.cn/zhengce/zhengceku/2018-12/31/content_5443536.htm.
- [2] Cong B, 2024, Basic Framework of Science and Technology System in the Field of Forensic Medicine. *Chin J Forensic Med*, 39(1): 5–7.
- [3] Zhang Z, Wu M, Zhang W, et al., 2020, Discussion on the Professional Reform of Forensic Medicine Under the Background of New Medical Science. *Journal of Chizhou University*, 34(03): 104–106.
- [4] Pu W, Gao R, Lin D, et al., 2024, Exploration on the Teaching Innovation Path of Pathology Course Under the Background of “New Medicine Science”. *China Continuing Medical Education*, 16(02): 31–36.
- [5] Zhang Y, Jiang Y, Chen L, 2024, Exploration and Thinking on the Integration of Ideological and Political Elements and Forensic Medicine Teaching Reform. *Ability and Wisdom*, 2024(06): 13–16.
- [6] Ministry of Education of China, 2020, Circular of the Ministry of Education of the People’s Republic of China on the Issuance of the Guiding Outline for Ideological and Political Construction of the Curriculum of Institutions of Higher Learning, visited on October 30, 2024, https://www.gov.cn/zhengce/zhengceku/2020-06/06/content_5517606.htm.
- [7] Zhong S, Li L, Nie S, et al., 2022, Exploration on the Ideological and Political Teaching of Forensic Biology Course with “Ideological and Political Case” as the Carrier. *Advances in Social Sciences*, 11(9): 3972–3978.

- [8] Center of Forensic Medicine, 2024, The Compilation Meeting of Forensic Medicine, A National Case Library of Ideological and Political Issues of Clinical Medicine for Higher Medical Education, Was Held Smoothly, visited on October 30, 2024, <https://forensmed.xjtu.edu.cn/info/1018/1514.htm>.
- [9] Chen R, Lai X, Xu C, et al., 2023, Reform of Online and Offline Mixed Teaching Mode Based on OBE: Taking the Course of Clinical Forensic Medicine as an Example. *Education and Teaching Forum*, 2023(07): 69–72.
- [10] Yuan J, Zhu Y, 2023, Practice and Thinking of Academic Tutorial System on Cultivating Undergraduates' Scientific Research Quality: Taking Practice of Henan University of Chinese Medicine as Example. *China Educational Technology & Equipment*, 2023(12): 101–104.
- [11] Meng S, 2023, Study and Practice of Course-Based Ideological and Political Education in Forensic Medicine. *Research on Education and Teaching*, 35(05): 116–121.
- [12] Wang X, Cai J, Liu Q, et al., 2010, The Implementation of “Student-Centered” Concept in Forensic Teaching Reform. *Medical Education Exploration*, 2010(7): 3.
- [13] Ge L, Jiang Q, Yan J, et al., 2024, Construction of Comprehensive Experimental Course of New Medical Major Based on OBE Concept. *Journal of Higher Education*, 10(02): 61–65.
- [14] Qi H, Wang X, Yang Y, et al., 2023, Research on the Application of CBL and TBL Dual-Track Teaching Method in the Course of TCM Basic Theory Based on OBE. *Western China Quality Education*, 9(17): 191–194.
- [15] Jia F, 2022, Analysis on the Application of CBL and TBL Dual-Track Teaching Methods Under OBE Concept in Forensic Medicine Teaching. *Chinese Continuing Medical Education*, 14(6): 24–28.

Publisher's note

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

Construction and Effective Utilization of Higher Vocational Off-Campus Practical Teaching Bases Based on School-Enterprise Cooperation

Yalan Zhang*

Guangzhou Huanan Business College, Guangzhou 510000, China

**Author to whom correspondence should be addressed.*

Copyright: © 2025 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: With the deepening of educational reform, off-campus practical teaching bases in vocational colleges must keep pace with the times. While enhancing their own construction and effective utilization, it is crucial to explore implementation strategies from a new perspective of school-enterprise cooperation to achieve the core goal of higher vocational education, that is, to cultivate high-quality technical and skilled talents. This paper proposes strategies for construction and effective utilization from aspects such as building a deeply integrated school-enterprise cooperation mechanism, optimizing the planning and layout of bases, improving the management system of practical teaching and strengthening the construction of “dual-qualified” teacher teams, and promoting the dynamic adaptation of practical training content to industrial demands, aiming to cultivate and enhance students’ comprehensive skills and qualities through these practical bases, thereby continuously boosting their employment competitiveness and ultimately improving the quality of talent cultivation and education.

Keywords: School-enterprise cooperation; Off-campus practical teaching base; Construction; Effective utilization

Online publication: November 14, 2025

1. Introduction

The core objective of higher vocational education is to cultivate high-quality technical and skilled talents, a feature that determines the key position of practical teaching. To achieve this goal, higher vocational education needs to define the core carrier, and the off-campus practice base connects the theoretical classroom with the on-the-job practice, and its bridging role also makes it play the role of the core carrier. Higher vocational off-campus practical teaching bases based on school-enterprise cooperation integrate two types of resources: school educational resources and enterprise industrial resources. By creating real job scenarios, they refine students’ skills and enrich their practical experience. At present, there is a problem of disconnection between the cultivation of skilled talents in higher vocational education and industrial demands. Focusing on the construction of off-campus practical teaching bases and achieving effective utilization is conducive to solving this problem. This

paper takes the importance of base construction and utilization as the starting point of the research and explores the implementation strategies based on school-enterprise cooperation, with the aim of providing useful references and lessons for improving the quality of higher vocational education ^[1].

2. The importance of the construction and effective utilization of off-campus practical teaching bases for higher vocational education

2.1. Align with the core objective of cultivating technical and skilled talents in higher vocational education

Analysis shows that the core demand is to cultivate technical and skilled talents who, in addition to having excellent skills, also possess high problem-solving abilities ^[2]. To achieve this goal, emphasis should be placed on creating a real job environment. Off-campus practical teaching bases provide students with a platform for practice. The seamless connection between this platform and professional positions enables students to bid farewell to traditional classroom simulation training methods, shortens the distance between them and the industry, and allows students can even come into contact with the latest technical equipment and management norms of the industry. For the base practice, teachers can guide students to participate in real projects of enterprises to help them transform theoretical knowledge, that is, to turn theoretical knowledge into practical skills, while strengthening the cultivation of students' professional qualities and job adaptability. For instance, having students go into enterprises and actually participate in enterprise projects can help them understand the work processes of enterprises and improve their practical skills. Such practical experiences have obvious advantages over on-campus training. The effective use of the base has narrowed the gap between talent cultivation and job requirements, which is conducive to enhancing students' employability ^[3].

2.2. Promote the integration and coordinated development of resources between schools and enterprises

The construction and utilization of off-campus practical teaching bases fundamentally entail the optimal allocation of resources between schools and enterprises, fostering coordinated development. From the perspective of the school, the enterprise can provide training equipment, practical projects, etc. for the base construction, which helps to make up for the school's insufficiency in training resources and solve the problem of its lagging technology update. At the same time, it also provides teachers with the opportunity to conduct practical operations on the front line and provides a strong boost for the construction of the dual-qualified teacher team ^[4]. From the perspective of enterprises, such teaching bases are conducive to solving the problem of labor shortage in enterprises, providing a window for enterprises to select and reserve talents. In practical teaching, enterprises can incorporate their own job requirements, technical standards, etc., so that the talents cultivated are more in line with their own needs. In addition, for the construction of the base, schools and enterprises can expand the scope of cooperation to cover areas such as technology research and development and project breakthroughs, so as to achieve the connection of the four chains (education chain, talent chain, industrial chain, innovation chain) and achieve a win-win situation for both schools and enterprises ^[5].

2.3. Enhance the capacity of higher vocational education to serve industrial development

The development of industries cannot do without higher vocational education. Therefore, constantly enhancing the capacity of higher vocational education to serve industrial development not only reflects its educational

value but also promotes the healthy and sustainable development of industries. Off-campus practical teaching bases, which originate from the front lines of industries, can capture the dynamics of industry development and the trends of industrial technological changes promptly, and pay attention to information feedback. By applying them to the revision of talent training programs, the optimization of the curriculum system and other links, it is conducive to narrowing the distance between higher vocational education and industrial development and promoting their synergy and resonance. Through the practice of the base, students are provided with a platform to familiarize themselves with industrial development, including industrial technical standards and development needs, so that they can integrate into the production and operation of enterprises without having to adapt for a long time after graduation, giving new vitality to industrial development ^[6]. At the same time, the base can also be used to carry out enterprise employee training, technology promotion, etc., and the school can provide corresponding technical support and talent training-related services based on its professional and talent advantages, which is conducive to enhancing the ability of higher vocational education to serve regional industrial upgrading and economic development ^[7].

3. Strategies for the construction and effective utilization of off-campus practical teaching bases in higher vocational colleges based on school-enterprise cooperation

3.1. Establish a school-enterprise cooperation mechanism to promote base construction and effective utilization

The foundation for the construction and effective utilization of bases is the establishment of a deeply integrated school-enterprise cooperation mechanism. For this purpose, both the school and the enterprise should start to establish a communication and connection mechanism and set up a base construction committee. In addition to management personnel from both the school and the enterprise, the committee also includes technical backbones and professional teachers, who are involved in the formulation of base construction plans, teaching programs, etc. In addition, the division of responsibilities between the school and the enterprise should be made clear, so that they can play to their strengths through their respective duties. If the school is responsible for student management, teaching management, etc., the enterprise needs to provide training venues, equipment, technical guidance and practical projects to improve the base construction and make it meet the needs of both the school and the enterprise. At the same time, establish a benefit-sharing and risk-sharing mechanism, and bind the interests of schools and enterprises together through order-based training, school-enterprise co-construction of training workshops, etc., to increase the enthusiasm of enterprises to participate and avoid formalism in cooperation ^[8].

For the cooperation mechanism to operate in the long term, emphasis should be placed on institutional building and use it as a guarantee. For example, schools should introduce incentive policies and incorporate teachers' participation in base construction and guidance of practical teaching achievements into the professional title evaluation and performance assessment system; Enterprises should set up special reward funds to recognize students and instructors who perform well in practice. In addition, establish a cooperative evaluation and feedback mechanism, assess the specific progress of base construction and the results of practical teaching through school-enterprise cooperation symposiums, actively solve problems in cooperation, and optimize and adjust cooperation content based on industrial development, teaching needs, etc., to continuously optimize the cooperation mechanism ^[9].

3.2. Optimize the construction plan to avoid waste of resources

The planning and layout of base construction should be based on the school's professional characteristics and aligned with the development plan of regional industries, to enhance the scientific nature of construction and avoid waste of resources. For this purpose, schools can select cooperative enterprises in combination with core professional clusters. When making the selection, not only should their industry reputation be considered, but also their technological advancement, cooperation intentions, etc., should be analyzed to lay the foundation for the construction of the backbone base. When building, the first step should be to define the functions and positioning of the base based on the professional practice requirements. For manufacturing majors, the training base should focus on production, while for service majors, it should focus on service, thus ensuring a precise match between the base's functions and the professional training objectives ^[10]. At the same time, pay attention to the regional layout of the base and give priority to local key enterprises when choosing cooperative enterprises to reduce the transportation cost of students' practical training, facilitate the teaching guidance provided by enterprises, and promote the long-term development of cooperation ^[11].

For the construction of the base's hardware and the creation of the environment, schools and enterprises, while increasing resource input, focus on optimizing them. For example, enterprises should improve the training grounds, equipment and facilities of the base in accordance with industry standards. On this basis, safety protection measures and training assistance tools should also be provided so that students can practice in the real job environment; Schools can improve teaching facilities through the practical teaching management platform built by enterprises, so that practical teaching can not only provide theoretical guidance but also meet the direct communication needs of teachers and students ^[12].

3.3. Establish and improve the practical teaching operation and management system to ensure the smooth implementation of practical teaching

The effective utilization of the base should focus on the effective operation and management of practical teaching. In addition to jointly formulating the teaching plan, both the school and the enterprise should also clarify the teaching objectives, assessment standards, etc., based on the talent cultivation plan + enterprise job requirements, and pay attention to the refinement of enterprise job skill standards and requirements to make them into corresponding practical teaching modules. At the same time, establish a dual-mentor system, namely enterprise mentors and on-campus mentors ^[13]. Among them, the former is appointed by the enterprise, usually by technical backbones, whose rich practical experience is conducive to providing effective guidance for students' practical training; The latter, appointed by schools, are usually teachers of higher professional level, mainly responsible for theoretical tutoring, teaching management, etc., to create a new pattern of guidance. At the same time, emphasis is placed on the formulation of the teaching process to clarify the specific requirements of each link, such as students' practical training registration, process guidance, etc., to lay the foundation for the smooth implementation of practical teaching ^[14].

On this basis, focus on the scientific management of the practical teaching process and strengthen quality monitoring to establish a new management mechanism. That is, the school and the enterprise jointly form a monitoring team to understand the training situation through various means, such as regular inspections and student feedback, and solve the problems that arise promptly. For this purpose, information technology can be used to build a platform and implement digital management to improve management efficiency. In addition, corresponding management systems should be established for students' training safety. On this basis, pre-job safety professional training should be actively carried out to enable students to understand what safe operation

is, be familiar with its operation norms, and be equipped with safety administrators to ensure the training process and help it develop in a safe and controllable direction ^[15].

3.4. Strengthen the construction of the “dual-qualified” teaching staff and improve the quality of practical teaching

The “dual-qualified” teaching staff serves as a crucial support for the effective utilization of the base, whose quality is closely related to the quality of practical teaching. For this purpose, schools can make use of off-campus practical teaching bases, establish long-term mechanisms for the teacher group, so that they can carry out practical training, and by formulating management measures for teachers to enter enterprises for practice, put forward specific requirements for professional teachers, that is, they need to go to the base enterprises for on-the-job training every year, actively participate in their technical research and other work, in order to understand the enterprise production process and technology application, To enhance their practical teaching skills. Enterprises should also actively create convenient conditions for this group of teachers by having their technical backbones, industry elites, etc., serve as their practical mentors to help teachers learn and master the latest technologies and job skills in the industry. At the same time, invite teachers to leverage their strengths to conduct employee training and participate in technological transformation in enterprises. Comprehensively enhance the teaching ability of teachers and the technological level of enterprises.

In addition, in order to broaden the channels for cultivating dual-qualified teachers, a teacher training system should be established based on school-enterprise collaboration. In addition to jointly participating in the formulation of teacher training programs, schools and enterprises should also invite technical experts from enterprises to give special lectures and technical demonstrations at schools, and encourage teachers to actively participate in industry-academic exchanges and skills competitions in order to transform teachers’ teaching concepts and update their professional knowledge. In addition, an evaluation and incentive mechanism for “dual-qualified” teachers should be established, linking teachers’ practical experience in enterprises, achievements in technical services, etc., with professional title evaluation and commendation, to enhance teachers’ enthusiasm and encourage them to consciously strive to be dual-qualified teachers and continuously improve their dual-qualified qualities.

3.5. Promote the dynamic adaptation of training content to industrial demands and enhance the practical value of the base

The training content is the link that connects teaching and industry at the base. Attention should be paid to the dynamic synchronization with the technological development of the industry and the job demands of enterprises, to avoid the separation of practical teaching and actual work, and thus enable the base to fully exert its educational value. During this process, both the school and the enterprise should focus on updating the content by establishing a dynamic update mechanism to conduct regular research on the development trends of local industries, the earliest standards of industry technology, and the capabilities of enterprise positions, to incorporate the latest production processes, operation norms, etc. into the training curriculum system. For majors such as new energy vehicles and artificial intelligence, enterprises should focus on the transformation of actual projects, such as transforming projects in areas like intelligent algorithm optimization and power battery testing into training tasks, creating conditions for students to be exposed to the most advanced technologies in the industry at the base; For traditional manufacturing specialties, the current training modules can also be adjusted and optimized based on the actual situation of the enterprise’s own equipment upgrade and production process improvement,

such as updating the traditional mechanical processing training method, that is, combining numerical control processing with industrial Internet monitoring, through this compound training, to ensure that the skills learned and mastered by students are more in line with the requirements of enterprise positions.

4. Conclusion

The construction and effective utilization of off-campus practical teaching bases for higher vocational education based on school-enterprise cooperation can not only enhance the quality of higher vocational education, but also ensure that the technical and skilled talents cultivated meet the demands of industries. By establishing a school-enterprise cooperation mechanism, promote the construction and effective utilization of bases; Optimize construction planning to avoid waste of resources; Strategies such as establishing a sound practical teaching operation and management system to ensure the smooth implementation of practical teaching can effectively address the drawbacks existing in the base construction. In the future, the connotation of school-enterprise cooperation should be deeply explored. While strengthening the construction of the base, the utilization model of the base should be innovated, so as to shorten the distance between higher vocational education and industrial development, promote the deep integration of the two, and meet the demand of social development for high-quality technical and skilled talents.

Funding

The 2024 “Quality Engineering” Project of Guangzhou Huanan Business College, “Off-Campus Practicum Base for Cross-border E-commerce Major at Guangzhou Dayang Education Technology Co., Ltd.” (Project No.: 2024HMZLGC07)

Disclosure statement

The author declares no conflict of interest.

References

- [1] Zhu Z, Yuan Q, Liu D, 2009, Exploration and Practice on Strengthening the Construction of Practical Teaching Bases. *Chinese University Teaching*, 2009(8): 66–67.
- [2] Luo H, 2014, Refining On-the-Job Evaluation to Deepen School-Enterprise Cooperation. *Biotechnology World*, 2014(4): 163.
- [3] Xie Y, Cai N, Liu Y, 2017, Research on the Long-Term Management Mechanism of Off-Campus Internship Bases for Higher Vocational Colleges. *Cultural and Educational Materials*, 2017(16): 144–145.
- [4] Jiang H, Du Q, Hu L, 2017, Practice and Exploration on the Construction of Off-Campus Practice Bases for College Students. *Journal of Taiyuan City Polytechnic College*, 2017(10): 39–40.
- [5] Lin X, Lin Y, Qin L, 2020, Construction and Reflections on Off-Campus Practical Teaching Bases for College Students: A Case Study of the Practical Bases of South China Normal University and Huizhou Ewatt Lithium Energy Co., Ltd. *University Education*, 2020(3): 149–151.
- [6] Wu M, Yan S, Zhu Z, 2024, Practice and Exploration on the Construction of Off-Campus Practical Teaching Bases

- for College Students. *Journal of Puyang Vocational and Technical College*, 37(1): 49–54.
- [7] He Y, Yu Y, 2024, Dilemmas and Solutions in the Construction of Practical Teaching Bases for Economics and Management Majors. *China Modern Educational Equipment*, 2024(3): 63–65.
 - [8] Zhang X, Zhan Y, 2023, Research on the Co-construction of Practical Teaching Bases by Colleges and Universities and Base Units. *Education Observation*, 12(13): 23–25 + 67.
 - [9] Li N, Wang Y, Wang X, 2023, Research on Strategies for Cultivating New Business Talents in the Digital Economy Era. *Science and Technology Entrepreneurship Monthly*, 36(8): 169–171.
 - [10] Zhang K, Sheng J, 2022, Discussion on the Construction of Off-Campus Practical Teaching Bases for Finance and Accounting Students. *Chinese Journal of Management Informatization*, 25(3): 217–220.
 - [11] Luo Z, 2022, Exploration on the Construction of Off-Campus Practical Teaching Bases in Application-Oriented Universities under the Background of New Engineering. *Journal of Heilongjiang Institute of Teacher Development*, 41(12): 38–40.
 - [12] Zhang L, Wang X, Zhang L, 2023, Research on the Construction of Off-Campus Practice Bases for Design Majors in Local Colleges under the Background of New Liberal Arts. *Journal of Suzhou University*, 38(5): 72–75.
 - [13] Sun C, 2019, Research on the Construction and Practice of Collaborative Education Practice Teaching Bases in Higher Vocational Colleges. *Computer Knowledge and Technology*, 2019(13): 119–120.
 - [14] Chen Z, 2021, Research on the Construction Model of Practical Teaching Bases in Higher Vocational Colleges. *Industry and Technology Forum*, 2021(21): 277–278.
 - [15] Zhang G, 2022, Exploration of Building New Off-Campus Practical Teaching Bases for Higher Vocational Hotel Management Majors: Based on Industry-Education Integration and Taking Qingchi Hot Spring Hotel as an Example. *Modern Business and Trade Industry*, 2022(14): 35–36.

Publisher's note

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

A Closed-Loop Integration Model of AI Technology in Junior Secondary Mathematics Teaching

Yongbo Liu*, Yue Li

School of Mathematical Sciences, Guizhou Normal University, Guiyang, Guizhou, China

**Author to whom correspondence should be addressed.*

Copyright: © 2025 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: The deep integration of digital transformation and artificial intelligence (AI) is driving profound changes in mathematics education. International forums like the 15th International Congress on Mathematical Education (ICME-15) have emphasized “reconstructing teaching paradigms through AI” as a central theme. However, current research often remains limited to a tool-oriented approach involving specific technologies, creating a disconnect between learning and teaching processes. This gap hinders a fundamental solution to the core challenge of balancing standardized education with personalized cultivation. To address this, this study proposes the “AI Dual-Loop Empowerment” model. This data-driven framework establishes a dynamic closed-loop system. Within the “student self-learning loop,” activities such as “preview” and “instant diagnosis” generate “learning data.” These data, in turn, drive the “teacher teaching loop,” where educators perform “learning analytics” and “implement interventions.” The outcomes of these interventions feed back into the students’ subsequent learning, creating a virtuous cycle in which “learning informs teaching and teaching promotes learning” and enabling continuous “data-driven decision.”

Keywords: AI in education; Junior secondary mathematics education; Dual-Loop empowerment model; Digital transformation of education; Scalable personalized instruction; Human-AI collaboration

Online publication: November 14, 2025

1. Introduction

The digital transformation of education is advancing globally, with breakthroughs in technologies such as generative artificial intelligence (AI) driving profound changes in the educational ecosystem^[1,2]. This trend is particularly pronounced in mathematics education. China’s 2022 Compulsory Education Mathematics Curriculum Standards explicitly emphasize the integration of information technology into mathematics teaching, with a core objective being the use of data to achieve “precision teaching” and “personalized learning”^[3]. This vision aligns with international priorities. For instance, the 2024 15th International Congress on Mathematical Education (ICME-15) elevated its focus from “how to use technology” to “how to reconstruct teaching paradigms through AI”^[4]. Similarly, the National Council of Teachers of Mathematics (NCTM) underscores that mathematics teachers serve as the bridge connecting students and AI^[5].

Despite the promising potential of AI in education, current research and practice face significant limitations:

(1) Tool-oriented tendency and lack of model construction

Existing research often focuses on validating specific AI functions, such as adaptive item banks or automated grading. While studies have confirmed the effectiveness of individual AI tools ^[6], they fail to elucidate how these tools systematically reshape the teaching structure. Although valuable, these “single-point breakthroughs” lack integration across the entire teaching process—including lesson preparation, instruction, assignments, assessment, and management—and have not yet coalesced into a unified, theoretically coherent instructional model.

(2) Predominance of unidirectional focus and neglect of dual-loop interaction mechanisms

Some studies primarily explore how AI assists teachers’ “teaching” ^[7], paying less attention to students’ “learning,” and rarely analyzing the data-driven, bidirectional closed-loop interaction mechanism between the two. How does the “student self-learning loop” precisely drive the “teacher teaching loop”? How do teachers’ interventions, in turn, optimize the “student self-learning loop”? This data-driven, bidirectional, closed-loop empowerment ecosystem represents a critical blind spot in current research.

(3) Ambiguity in human-AI collaboration and unclear role definition

Although “human-AI collaboration” is a recognized concept ^[8], discussions on its specific mechanisms and division of responsibilities remain largely conceptual, lacking actionable implementation frameworks. Should AI replace teachers’ repetitive tasks or act as an “amplifier” of their pedagogical expertise? How should responsibilities be delineated in classrooms where “AI teachers” and human teachers coexist? How can teachers critically evaluate AI-generated content while infusing it with indispensable emotional support and creative instructional design? These pivotal questions urgently require clarification through the development of a clear model.

To address this gap, this study proposes an innovative “AI Dual-Loop Empowerment” theoretical model. The study first outlines the six theoretical foundations underpinning the model, then elaborates on its core components and operational mechanisms. Finally, it demonstrates the model’s theoretical coherence and practical value through a derivation based on a hypothetical junior secondary mathematics teaching scenario.

2. Theoretical foundation

The construction of the “AI Dual-Loop Empowerment” model is well-grounded, drawing deeply from a series of classical and contemporary learning science theories. Collectively, these theories provide a solid foundation for the model’s rationality, innovation, and feasibility.

2.1. Cornerstone classical theories

(1) Mastery learning theory

Systematically proposed by the renowned educational psychologist Benjamin Bloom, this theory posits that the vast majority of students can achieve mastery of knowledge and skills, provided they are given sufficient learning time, appropriate instructional conditions, and frequent formative assessment with feedback. The theory emphasizes ensuring students fully grasp fundamental concepts before progressing to subsequent learning. Within the present model, mastery learning theory forms the underlying logic and core objective of realizing the ideal of “large-scale individualized instruction.” The “instant diagnosis” within the “student self-learning loop” continuously identifies students’ knowledge weaknesses where

mastery has not been achieved. The “teacher teaching loop” then leverages this information to conduct “precise instructional design” and “management intervention,” ensuring collective progress for most students. The work of Nye et al., which integrated the AutoTutor and ALEKS systems, demonstrates the effectiveness of continuous diagnosis and personalized support via adaptive technology, providing a practical reference for the “dual-loop” operation of this model ^[9].

(2) Constructivist learning theory

This theory contends that knowledge is not passively received from teachers but is actively constructed by learners through interaction with their environment, with support from others (including teachers and peers) and necessary learning resources. In this model, constructivism provides the fundamental rationale for how the “dual loops” foster deep learning. The “student self-learning loop” utilizes digital tools like interactive micro-videos and dynamic geometry to create low-threshold, highly interactive virtual exploration environments, effectively stimulating students’ active meaning-making as cognitive agents ^[10]. Conversely, the “teacher teaching loop,” by organizing group discussions and collaborative problem-solving based on “learning analytics,” places individual preliminary understandings within a learning community for negotiation and refinement, embodying the crucial role of social interaction in knowledge construction ^[11].

(3) Distributed cognition theory

This theory posits that cognition is not confined solely to an individual’s mind but is distributed across individuals, tools, symbol systems, and the environment that constitute a functional system. In this model it provides the core framework for understanding the essence of “human-AI collaboration.” It reveals that the “student self-learning loop” and the “teacher teaching loop” are not merely functional additions but constitute a dynamic, distributed cognitive system. Research by Guo et al. emphasizes the critical importance of maintaining “human agency” as central in collaborations with AI, noting that a loss of student ownership can diminish their agency ^[12]. Haraldsrud et al. highlight the importance of students effectively coordinating generative AI as a cognitive partner, distinguishing between “productive” and “unproductive” interaction patterns ^[13]. This finding serves as both a caution and a guide for designing the “self-learning loop” in this model. Ferrario et al., arguing from a philosophical epistemological standpoint, demonstrate that when humans successfully “appropriate” AI to form a “hybrid cognitive agent,” they can exhibit cognitive capabilities surpassing those of the individual parts, thereby attaining genuine epistemic authority and subsequently achieving an overall leap in teaching efficacy ^[14]. Together, these studies—from sustaining human agency and optimizing interaction patterns to arguing for the legitimacy of hybrid agents—provide theoretical grounding for the “human-AI collaboration” design in this model, spanning micro to macro levels.

2.2. Contemporary theoretical perspectives

(1) Precision education theory

Precision education is a data-driven paradigm that leverages advanced information technologies, such as artificial intelligence and learning analytics, to comprehensively collect and analyze learning process data, thereby achieving personalized education ^[15]. The present model represents a concrete instantiation of the precision education paradigm within the classroom teaching context. The success of the “precision education timely intervention system” developed by Lee et al. in K-12 STEM fields provides cross-disciplinary support for the model’s core assumptions ^[16]. Furthermore, the hybrid deep learning

framework constructed by Altaf et al. methodologically illustrates the required technical depth and data breadth for realizing precision education ^[17]. Precision education theory offers comprehensive support for the “AI Dual-Loop Empowerment” model, from conception to practice. Specifically, the “self-learning loop” enables the data-driven diagnosis essential to precision education, while the “teaching loop” facilitates the personalized, timely interventions that precision education pursues.

(2) Learning analytics and the closed-loop paradigm

This field aims to understand and optimize learning environments by analyzing learner data. When this process forms a dynamic cycle of “data-analysis-intervention-feedback,” it constitutes the core mechanism for scalable personalized cultivation—the “closed-loop paradigm.” Within the present model, learning analytics and the closed-loop paradigm function as its “nervous system” and “circulatory system,” respectively. Hahn’s research validates the feasibility of closed-loop learning analytics models and identifies “teacher type” and “intervention timing” as key variables ^[18]. AlZoubi further reveals that teachers’ “sensemaking processes” regarding data dashboards act as the bridge from data to intervention within the closed loop ^[19]. The temporal machine learning approach developed by Nur provides an advanced data analysis tool for enabling proactive and intelligent closed loops ^[20]. Collectively, these studies demonstrate that the “dual-loop” system constructed in this model constitutes a complete and evolvable teaching closed-loop ecosystem. It aligns with the principles of learning science, possesses a solid technical foundation, and fully acknowledges the central role of the teacher.

(3) Data-driven decision-making and human-AI collaboration

Data-driven decision-making refers to the paradigm of formulating teaching strategies, implementing educational interventions, and optimizing teaching processes through the collection and analysis of data. Its integration with AI has given rise to a new educational ecology of “human-AI collaboration.” Ji’s research found that in AI-integrated teaching, the teacher’s role is transformed rather than replaced, with their pedagogical authority and agency being central to effective integration ^[21]. The mixed-methods study by Hussain et al. confirms that the integration of AI is redefining the roles of teachers and students and reshaping learning experiences, emphasizing that AI should serve as a “tool” to enhance educational experiences ^[22]. This provides a theoretical anchor for the role division and collaborative relationship between teachers and AI within the present model.

In summary, these six theories form a clear, hierarchical, and mutually supportive framework, establishing a solid theoretical foundation for the “AI Dual-Loop Empowerment” model. This framework indicates that mastery learning theory defines the model’s foundational goal. Constructivist and distributed cognition theories explain the internal mechanics of the “dual loops” from the perspectives of individual knowledge construction and human-AI system synergy, respectively. Building upon this, the precision education paradigm establishes the core philosophy of data-driven instruction. Learning analytics and the closed-loop paradigm provide the methodological support for realizing the closed flow of data and intervention feedback. Finally, data-driven decision-making and human-AI collaboration fundamentally delineate the functional boundaries and interactive relationships between teachers and AI within the collaborative teaching process.

3. Construction of the AI dual-loop empowerment model

3.1. Model framework and core components

The “AI Dual-Loop Empowerment” model is a data-driven, closed-loop instructional system that integrates the

“student self-learning loop” and the “teacher teaching loop” (**Figure 1**). Its core components are as follows:

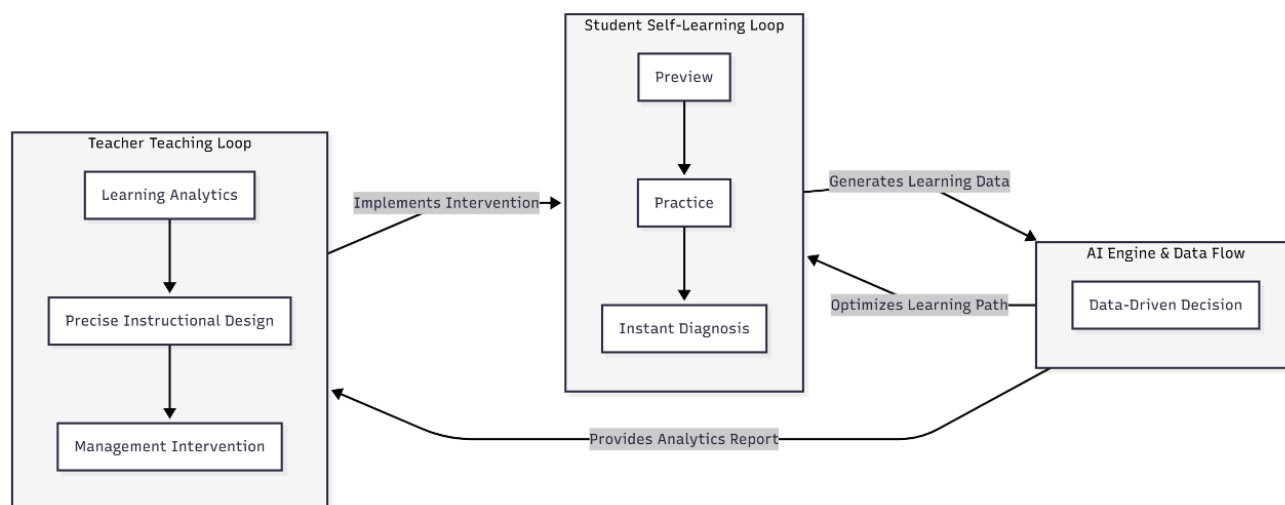


Figure 1. The AI dual-loop empowerment model.

(1) The “student self-learning loop”

This loop operates primarily during the “preview” and “practice” stages. Students use an AI platform for content preview and consolidation exercises. The platform, leveraging its built-in AI engine (e.g., machine learning models, knowledge graphs), collects and analyzes learning behavior data (e.g., video viewing duration, pause points, answer accuracy, response time) in real time. This enables “instant diagnosis” and subsequently “optimizes learning path,” providing students with personalized learning support.

(2) The “teacher teaching loop”

This loop spans the entire teaching process, including lesson preparation, in-class instruction, and after-class tutoring. Teachers access the “learning analytics” report generated by the “student self-learning loop” via the platform. Based on this analysis, they conduct “precise instructional design” (e.g., adjusting teaching priorities, designing tiered tasks) and “management intervention” (e.g., individual tutoring, resource pushing). After teachers “implement intervention,” the effects are fed back into the system as new data.

(3) Data flow and AI engine drive

Data serves as the core link connecting the two loops, while the “AI engine & data flow” acts as the intelligent center of the system. The learning data generated by the “student self-learning loop” is analyzed by the AI engine, which then drives teaching decisions and intervention actions within the “teacher teaching loop.” Data on the effects of teacher interventions (e.g., classroom performance, assignment quality) is fed back to the “student self-learning loop,” influencing subsequent diagnosis and path optimization. This process forms a continuously iterative, self-optimizing closed-loop instructional ecosystem, achieving genuine “data-driven decision.”

3.2. Operational mechanism characteristics

- (1) Data-driven: The model operates entirely on objective, continuous learning data, shifting teaching decisions from being experience-driven to evidence-driven.

- (2) Dual-loop linkage: "Learning" and "teaching" are tightly coupled through real-time data flow, forming an organic whole that mutually drives each other. This implements the scalable teaching mechanism of "letting learning determine teaching and letting teaching promote learning" in practice.
- (3) Human-AI collaboration: The model clarifies the division of roles between AI and teachers. AI acts as a "super teaching assistant," handling repetitive, computational tasks and providing data insights. The teacher serves as the "learning commander," responsible for emotional guidance, cognitive stimulation, creative instructional design, and the final review of AI output, ensuring the dominance of human cognition within the system.

This framework is universal; its core mechanisms, "data-driven," "dual-loop linkage," "human-AI collaboration," can be adapted to different subject contents and teaching scenarios.

4. Teaching derivation: The case of "Completing the square for quadratic equations"

To concretize the operational mechanism of the model, this study conducts a hypothetical teaching derivation using the junior secondary mathematics topic "completing the square for quadratic equations" as an example.

(1) "Student self-learning loop" (Pre-class)

Students watch an instructional micro-video on completing the square and complete fundamental exercises on the AI platform. Through "instant diagnosis", the platform identifies that approximately 60% of students make errors in the specific step of "handling quadratic equations where the leading coefficient is not 1," while also flagging individual students struggling with the conceptual understanding of "perfect square trinomials." Consequently, the system "optimizes learning path" by pushing targeted review materials to the relevant students.

(2) Data Flow and the "Teacher Teaching Loop" (Lesson Preparation)

The teacher reviews the "learning analytics" report and decides to focus the upcoming classroom instruction on the technique for "completing the square when the leading coefficient is not 1," designing an inquiry-based activity around it. Simultaneously, the teacher prepares strategies for providing in-class attention and after-class tutoring plans for the identified individual students.

(3) "Teacher Teaching Loop" (In-class)

The teacher begins the lesson by introducing a real-life scenario problem. The instruction then focuses on guiding students to explore and summarize the specific steps for the targeted technique. Addressing the common error, the teacher organizes group discussions, allowing students to self-analyze and correct their misunderstandings, thereby implementing a precise teaching intervention.

(4) Closed-loop Feedback (Post-class)

The teacher assigns tiered assignments. Based on the new data from classroom performance and assignment completion, the platform regenerates the learning analytics report. This new data indicates significant improvement regarding the previously common weakness, though some individual students still require further attention. The system again "optimizes learning path" based on this updated information, and the teacher plans the next cycle of "management intervention." This concludes one full cycle of the "dual-loop" process, immediately initiating a new instructional iteration.

5. Discussion and conclusion

The “AI Dual-Loop Empowerment” model constructed in this study provides a valuable supplement to existing theories of AI in education. It transcends the perspective of treating AI as a mere tool, elevating it to a core driver for restructuring the teaching process and optimizing pedagogical relationships.

5.1. Theoretical contribution

The model directly addresses the three major research limitations identified earlier. Firstly, it counters the “tool-oriented” tendency by proposing a systematic, top-down designed model. Secondly, it remedies the insufficiency of “unidirectional” research by elucidating the data interaction mechanism between the dual loops. Finally, drawing on theories like distributed cognition, it clarifies the division of roles between teachers and AI within “human-AI collaboration,” thereby resolving the ambiguity surrounding its conceptual connotation. This direction aligns closely with the ICME-15 agenda of “reconstructing teaching paradigms through AI”^[4].

5.2. Practical implications and future research

This model offers a clear blueprint for frontline teachers to integrate AI into their teaching practice, provides a feasible entry point for schools to advance their digital transformation, and supplies a theoretical basis for educational technology companies to optimize product design. While this study focuses on theoretical construction, the model’s efficacy, adaptability to different school contexts, and long-term impact require further validation and refinement through rigorous empirical research in subsequent studies.

In summary, the “AI Dual-Loop Empowerment” model proposed herein offers a theoretically coherent and mechanistically explicit solution to the core educational contradiction of scaling standardization versus personalization. Future empirical research will be dedicated to testing its effectiveness and promoting its deeper integration and application across a wider range of educational scenarios.

Disclosure statement

The authors declare no conflict of interest.

References

- [1] Yan K, Duan MH, Zhang YQ, 2025, Theoretical Evolution Framework and Trends of AI-Enabled Education. *Tsinghua Journal of Education*, 46(2): 33–42 + 84. .
- [2] Ding L, Wu S, 2024, Digital Transformation of Education in China: A Review Against the Backdrop of the 2024 World Digital Education Conference. *Science Insights Education Frontiers*, 20(2): 3283–3299.
- [3] Ministry of Education of the People’s Republic of China, 2022, *Mathematics Curriculum Standards for Compulsory Education*. Beijing Normal University Press, Beijing.
- [4] Kang Y, Zhang J, Song C, 2024, Frontiers and Future Directions of International Mathematics Education Research in the Digital-Intelligent Era: A Review Based on Invited Parallel Reports at ICME-15. *Journal of Mathematics Education*, 33(5): 67–73.
- [5] National Council of Teachers of Mathematics, 2024, *Artificial Intelligence and Mathematics Teaching*, visited on August 30, 2025, <https://www.nctm.org/standards-and-positions/Position-Statements/Artificial-IntelligenceandMathematicsTeaching/>.

- [6] Zeng P, 2025, Effective Application of Artificial Intelligence in Junior Secondary Mathematics Teaching. Proceedings of the 2024 (Second Half) “Electronic Technology and Information Science” Symposium, Guangdong Provincial Electronics Society, Guangdong Shenzhen Bao’an Tangwei Wanli School, 2–5.
- [7] Tuanaya R, Retnawati H, 2024, Book Review: Empowering Primary Mathematics Educators: Strategies for Addressing Anxiety in the Classroom; Karen Wicks (2021) Tackling Anxiety in Primary Mathematics Teachers. Educational Studies in Mathematics, 117(1): 163–166.
- [8] Zhu Z, Wang M, 2023, Mathematics Education in the Age of Artificial Intelligence. Primary and Secondary School Classroom Teaching Research, (6): 1–6.
- [9] DBN, IPP, Alistair W, et al., 2018, SKOPE-IT (Shareable Knowledge Objects as Portable Intelligent Tutors): Overlaying Natural Language Tutoring on an Adaptive Learning System for Mathematics. International Journal of STEM Education, 5(1): 12.
- [10] Li W, Liu X, Zhang Q, et al., 2023, VR-Enhanced Cognitive Learning: Method, Framework, and Application. Applied Sciences, 13(8): 4756.
- [11] Grobler R, Ankiewicz P, 2021, The Viability of Diverting from a Linear to a Parallel Approach to the Development of PCK in Technology Teacher Education. International Journal of Technology and Design Education, 32(2): 1–21.
- [12] Guo W, Liang Z, Wang C, et al., 2025, Student-AI Collaborative Creative Problem-Solving: The Role of Human Agency. Computers & Education, 239: 105433–105433.
- [13] Haraldsrud A, Odden TOB, 2025, Bridging Artificial Intelligence and Real Intelligence: Self-Scaffolding Computational Modeling with Generative AI in Chemistry. Journal of Chemical Education, 102(10): 4255–4266.
- [14] Ferrario A, Facchini A, Termine A, 2024, Experts or Authorities? The Strange Case of the Presumed Epistemic Superiority of Artificial Intelligence Systems. Minds and Machines, 34: 30.
- [15] Laurah T, Shubha V, et al., 2023, Demystifying AI: Current State and Future Role in Medical Education Assessment. Academic Medicine: Journal of the Association of American Medical Colleges, 99(4S): S42–S47.
- [16] Lee H, Lin C, Wang W, et al., 2023, Precision Education via Timely Intervention in K-12 Computer Programming Course to Enhance Programming Skill and Affective-Domain Learning Objectives. International Journal of STEM Education, 10: 52.
- [17] Altaf S, Asad R, Ahmad S, et al., 2023, A Hybrid Framework of Deep Learning Techniques to Predict Online Performance of Learners During COVID-19 Pandemic. Sustainability, 15(15): 11731.
- [18] Hahn L, 2023, The Relationship of Instructor-Type and Intervention in a First-Year Seminar Using a Closed-Loop Analytics Model, thesis, Northern Arizona University.
- [19] AlZoubi D, 2022, Unpacking Instructors’ Use and Sensemaking Processes of Feedback Dashboards: A Human-Centered Approach, thesis, Iowa State University.
- [20] Nur N, 2021, Developing Temporal Machine Learning Approaches to Support Modeling, Explaining, and Sensemaking of Academic Success and Risk of Undergraduate Students, thesis, The University of North Carolina.
- [21] Ji H, 2025, Teaching with Conversational AI: Exploring Human-AI Collaboration and the Beliefs and Experiences of Language Teachers, thesis, Temple University.
- [22] Hussain D, Rasool D, Tabassum S, 2025, Human-AI Collaboration in Education: Rethinking the Role of Teachers and Learners in the Age of Intelligent Technologies. Academia International Journal for Social Sciences, 4(3): 2643–2653.

Publisher’s note

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

Research on the Optimization Path of Student Monitor of Instruction in Universities

Xiujuan Sun*

Taishan University, Tai'an 271000, Shandong, China

**Author to whom correspondence should be addressed.*

Copyright: © 2025 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: Under the “student-centered” educational philosophy, student participation in teaching management is an inevitable requirement for improving the quality of higher education. As a key link connecting “students—teachers—d mentors—universities,” Student Monitor of Instruction play an irreplaceable role in teaching information feedback, quality supervision, and academic atmosphere building. Currently, university teaching quality monitoring faces problems such as insufficient manpower and limited coverage. As firsthand participants in the entire teaching process, students are conducive to improving the teaching quality assurance system. Drawing on practical experiences from multiple universities, this paper systematically proposes optimization paths for the work of Student Monitor of Instruction from four dimensions: constructing diversified incentive mechanisms, improving systematic training systems, establishing multi-agent collaboration mechanisms, and optimizing operational environments. It provides practical references for universities to enhance the effectiveness of teaching quality assurance.

Keywords: Student Monitor of Instruction; Teaching quality assurance; Optimization paths

Online publication: November 14, 2025

1. Practical significance of the student monitor of instruction system

Against the background of the high-quality development of higher education, the construction of student monitor of instruction system has become a core task for the comprehensive development of universities. Currently, the teaching quality monitoring of domestic universities mainly relies on teaching evaluation departments, academic affairs departments, and supervision groups, which generally face problems such as insufficient staffing and incomplete monitoring coverage, making it difficult to achieve comprehensive and real-time monitoring of daily teaching order^[1]. Although the evaluations of supervision groups are highly professional, limited by manpower and time, they can only cover a limited number of courses and classrooms, failing to fully reflect the true situation of all teaching links.

As direct participants and experiencers of teaching activities, students are natural subjects of teaching quality evaluation. The 2017 Ministry of Education’s “Regulations on the Administration of Regular Institutions of Higher Education” clearly proposes to “encourage students to exercise self-management, self-

service, self-education, and self-supervision” and endows students with legal rights such as “participating in school management in appropriate ways” and “enjoying the right to know, participate, express, and supervise school affairs.” This provides a systematic basis for students to participate in teaching management and clarifies their dominant position in teaching quality assurance. Under the OBE (Outcome-Based Education) concept, the orderly development of the work of student monitor of instruction (hereinafter referred to as “monitor”) is conducive to further giving play to students’ dominant role ^[2]. As a core component of the university’s teaching quality assurance system, the team of student monitor of instruction, through conducting evaluations throughout the teaching process, including learning climate, teaching climate, and teaching resources, forms a diversified quality evaluation subject together with teaching supervision, peer review, and management evaluation. As a key channel for teaching management departments to collect frontline opinions, they play an irreplaceable role in teaching quality management ^[3]. The work of monitor can improve the level of teaching management to a certain extent and is conducive to the formation of a good teaching climate and excellent learning climate ^[4]. Therefore, how to optimize the working mechanism of monitor and fully release their quality assurance value has become an urgent practical issue for universities.

2. Constructing diversified incentive mechanisms to stimulate monitor’ work enthusiasm

Motivating the work enthusiasm of monitor is a core prerequisite for the effective operation of the system. A long-term incentive mechanism combining material rewards, spiritual incentives, and growth empowerment should be adopted. Shaanxi Open University has effectively improved students’ participation initiative through diversified incentive methods, and the quantity and quality of feedback from excellent monitor have been significantly enhanced ^[5].

2.1. Clarifying reward and punishment standards and building a dynamic assessment system

Universities should formulate scientific, reasonable, and measurable “Measures for the Assessment and Management of Student Monitor of Instruction”, taking the timeliness, accuracy, and contribution to problem-solving of information feedback as core assessment indicators, and incorporating work performance into the practical credit recognition system. Select “Excellent Teaching Monitor” annually and provide incentives such as moral education extra points, and material rewards to stimulate students’ enthusiasm for participating in management and effective expression. A questionnaire survey of monitor in the author’s university shows that 36.49% of respondents believe that “the lack of incentive mechanisms” is the main factor affecting work enthusiasm; in terms of reward needs, 58.11% hope to obtain extra points in comprehensive quality evaluation, and 46.85% expect preferential policies in selection and awards. A punishment mechanism should be set up for those who fail the assessment, such as an monitor withdrawal mechanism and denial of moral education extra points, to reversely encourage monitor to perform their job responsibilities ^[3]. Relevant departments should regularly pay attention to the work of monitor, give timely recognition, guidance, and help, and ensure the continuous effectiveness of the monitor system.

2.2. Strengthening spiritual identity and enhancing the sense of post value

Allow monitor to personally participate in the design and revision of the monitor work system to enhance their

understanding and sense of participation in this work^[6]. Through ritual designs such as holding appointment ceremonies and issuing official appointment letters, enhance monitor' sense of responsibility and honor. Nanchang Hangkong University has significantly strengthened monitor' sense of work mission by having leaders personally issue certificates and deliver messages^[7]. Publicly commend the work achievements of excellent monitor through multiple channels regularly, such as publishing advanced deeds in the "Student Monitor of Instruction Work Briefing", so that monitor can feel that their work value is recognized, enhance their personal sense of honor, and stimulate their subjective initiative. The questionnaire survey shows that 53.92% of respondents rank "follow-up improvement of feedback problems" as the primary factor affecting work enthusiasm, indicating that the closed-loop problem rectification and effect notification can make monitor gain a sense of identity and are the key to stimulating their participation enthusiasm.

2.3. Empowering capacity growth and expanding development space

Through organizing professional systematic training and providing rich practical training opportunities, focus on cultivating monitor' core competencies such as interpersonal communication skills, data analysis capabilities, teamwork abilities, and problem-solving skills^[8]. The explicit results of these ability improvements, such as work performance reports and ability assessment certificates, can be used as important reference bases for selection and awards, postgraduate recommendation, job hunting, and employment, and other important links. In addition, special scholarships for monitor can be considered to further encourage students to actively participate in the work of monitor.

3. Improving systematic training systems to enhance monitor' professional literacy

In reality, when monitors lack proper training, the data they collect is compromised from the outset, hindering effective analysis and use. For example, monitor ignore the characteristics of teachers or courses and score teachers based on their own preferences^[9]. Scientific and systematic training is a key guarantee for improving the work quality of monitor, and a three-dimensional training system of "pre-service training + regular seminars + special improvement" should be constructed.

3.1. Consolidating pre-service basic training and clarifying work norms

Implement systematic pre-service training of "theory + tools + cases + Q&A" for newly appointed monitor. The training content includes organizational structure, role positioning, rules and regulations, job responsibilities, operation of feedback tools, and work standards. Through standardized training manuals and practical demonstrations, help monitor quickly grasp the core requirements of the work. Only with standards can there be quality, and only with quality can there be effects. Harbin Medical University arranges pre-service training courses taught by chief teaching supervisors to ensure that monitor accurately understand work requirements^[10].

3.2. Conducting regular experience exchanges to promote capacity improvement

Regularly organize monitor forums to review phased work results and discuss optimization directions^[11]; establish an "old guiding new" mentoring mechanism, where excellent monitor share practical skills and lessons learned to play a demonstration and leading role^[7]; conduct special seminars on difficult issues in teaching feedback; organize monitor team building activities to enhance team cohesion and cooperation

awareness among members. Departments responsible for monitor management, such as the Academic Affairs Office, regularly produce the “Student Monitor of Instruction Work Briefing” to let monitor understand the progress of work and problem-solving, and also learn from the work experience of excellent monitor, creating an open and positive working environment with smooth information flow.

3.3. Strengthening specialized skill training to match post requirements

Carry out specialized skill training according to actual work needs: first, general ability training, including teaching evaluation methods, communication skills, observation and recording norms, basic data analysis, etc., which not only improves post competence but also helps students’ career development; second, shortcoming compensation training, such as special training on “interpretation of teaching evaluation indicators” for the problem of “vague and general feedback information”, and practical training on “operation of teaching quality management platforms” and “basic data analysis” for information needs. Improve training effectiveness through simulated scenarios, case discussions, and other methods.

4. Establishing multi-stakeholder collaboration mechanisms to build a quality assurance community

The effective operation of the Monitor system needs to break down barriers between stakeholders and build a closed-loop mechanism of multi-party collaboration.

4.1. Smoothing feedback channels to achieve efficient circulation

Build an information-based teaching feedback platform integrating “real-time submission, status tracking, and data analysis” to replace the traditional “offline form filling” model and improve work efficiency. Establish a four-level feedback network of “monitor—teachers—secondary colleges—functional departments,” clarifying the responsible subjects and processing time limits of each link. Guangxi University of Foreign Languages regularly publicizes feedback information, and the number of effective feedbacks has increased from 760 to 3113 within one year, with a significant improvement in feedback quality^[12]. The School of Food Engineering of Heilongjiang East University adopts a “1+N” information collection and feedback model to comprehensively and three-dimensionally collect and sort out effective teaching feedback information and form a summary report^[13]. The author’s university has realized the normalization of weekly online feedback through an information-based platform, and work efficiency and data analysis capabilities have been significantly improved.

4.2. Strengthening departmental collaboration to improve rectification effectiveness

Expand the application scenarios of feedback data to serve the construction of learning climate, optimization of teaching climate, and improvement of teaching management; establish an inter-departmental coordination mechanism, clarify the division of responsibilities among the Academic Affairs Office, Student Affairs Office, Logistics Office, and secondary colleges, and build a closed-loop management model of “problem accounting book—rectification list—effect tracking”. For example, a university classifies and forwards feedback problems to responsible departments through the “Teaching Information Review and Handling Form” system, processing 60–70 review and handling forms annually, realizing “every matter has a response and every case is resolved”^[10]. Another university has gradually established a closed-loop teaching feedback mechanism,

which has been well evaluated by student monitor^[14]. For complex problems involving multiple departments, school leaders preside over joint office meetings to coordinate solutions.

4.3. Deepening teacher-student interaction to create a co-governance atmosphere

Establish a regular communication mechanism between monitor and teachers, such as organizing “teacher-student forums” to promote direct dialogue between the two parties. Through training and publicity, the university guides teachers and students to change their perception of the monitor system and establish the concept of “partners in teaching improvement.” Encourage monitor to put forward constructive improvement suggestions while providing feedback on problems, avoiding them from becoming mere “problem reporters.” Increase positive feedback channels for monitor, such as recommending high-quality classrooms and excellent teachers. The university sets up a column “Excellent Teachers in Students’ Minds” in the “Student Monitor of Instruction Work Briefing”, extracting high-quality classrooms, excellent teachers, and monitor’s recommendations. While giving play to the exemplary role of excellent teachers, it can also promote the harmony of teacher-student relations.

4.4. Working in synergy with instructional supervisors to enhance the effectiveness of the quality assurance system

Establish a linkage mechanism between monitor’s feedback and supervisors’ classroom observations, taking high-frequency problems feedbacked by monitor as key concerns of supervisors’ classroom observations, and allowing supervisors to focus on helping teachers with poor teaching quality. At the same time, use the feedback data from monitor as an important reference for teachers’ teaching quality evaluation, professional assessment, and course application.

5. Optimizing the operational environment of the monitor system to strengthen quality assurance effectiveness

To ensure the continuous and effective operation of the monitor system, it is necessary to optimize the supporting environment from aspects such as system design, college participation, and cultural cultivation.

5.1. Improving system design and clarifying operational norms

Formulate the “Measures for the Management of Student Monitor of Instruction”, clearly specifying the selection criteria, job responsibilities, rights and obligations, and reward and punishment mechanisms of monitor. The system design should reflect the “student-centered” concept, establish a dynamic system revision mechanism, and regularly optimize system clauses according to operational effects and feedback from teachers and students.

5.2. Strengthening college management and fulfilling job responsibilities

The questionnaire survey shows that some monitor are not aware of the reward measures and incentive methods of secondary colleges; individual students reflect that colleges do not attach sufficient importance to the work of monitor. This indicates that, as a key node in the four-level feedback network of “students—teachers—colleges—functional departments,” secondary colleges have problems such as insufficient subjective initiative and inadequate role play. Secondary colleges need to make efforts from three aspects:

improving awareness, improving systems, and implementing measures to actively tap the value of monitor in quality assurance.

5.3. Cultivating quality culture and building a co-governance ecosystem

Promote the value and effectiveness of the monitor system through campus radio, WeChat official accounts, and other channels, and guide teachers to regard student feedback as an important basis for teaching improvement^[15]. Cultivate students' sense of quality subjectivity. The university invites monitor to participate in school and college-level academic affairs meetings to enhance their sense of participation and responsibility, and promote information feedback to become an active behavior. With the joint efforts of the whole university, a quality culture of “teaching and learning promote each other and quality is jointly safeguarded” is formed.

6. Conclusion

The student monitor of instruction system is an important support for the university's teaching quality assurance system. Its long-term operation depends on the traction of diversified incentive mechanisms, the empowerment of systematic training systems, the collaboration of multi-agent linkage mechanisms, and the guarantee of a sound operational environment. Universities need to adhere to the “student development-centered” concept, continuously optimize system design and practical paths, fully release the value of monitor in dynamic teaching feedback, promotion of teacher-student interaction, and continuous quality improvement, and provide strong support for improving the teaching quality assurance system and enhancing the quality of talent cultivation.

Funding

The 16th Teaching Reform Project of Taishan University, “Research on the Dual Feedback System of Student Monitor of Instruction Based on Process Evaluation” (Project No.: JG202416)

Disclosure statement

The author declares no conflict of interest.

References

- [1] Ma C, Zhang T, Zhai H, et al., 2019, Discussion on the Student Monitor of Instruction for University Teaching Quality Monitoring. *Journal of Northeast Agricultural University (Social Science Edition)*, 17(2): 89–93.
- [2] Chen Y, 2022, Research on the Management Strategies of Student Monitor of Instruction. *Modern Vocational Education*, 2022(16): 160–162.
- [3] Hu D, Yu L, Tang H, 2021, Research on the Problems of Teaching Feedback from Student Monitor of Instruction in Undergraduate Colleges—Taking W College as an Example. *Journal of Beijing Institute of Graphic Communication*, 29(S2): 152–154.
- [4] Wang S, 2021, Thoughts on the Construction of the Student Monitor of Instruction System in Universities. *Journal of Jiamusi Vocational Institute*, 2021(04): 129–131.
- [5] Ma S, 2024, Research on the Management Strategies of Higher Vocational Student Monitor of Instruction under the

Background of the “Double High-Level Plan”. *Journal of Shaanxi Open University*, 26(03): 45–55.

- [6] Liu Y, 2024, Research on the Operation Mechanism of the Work of Student Monitor of Instruction in Local Universities. *Journal of Jilin Provincial College of Education*, 40(09): 103–107.
- [7] Ao Y, Wang J, Wang L, 2020, Practical Exploration and Reflection on the Student Monitor of Instruction System in Universities—Taking Nanchang Hangkong University as an Example. *Journal of Nanchang Hangkong University (Social Science Edition)*, 22(4): 86–92.
- [8] Yan L, 2023, The Operation Mechanism and Problems of the Student Monitor of Instruction System in Higher Vocational Colleges. *Science & Education Vision*, 2023(10): 24–27.
- [9] Liang F, Wang Y, 2023, Research on the Construction of Graduate Education Student Monitor of Instruction Supervision Organization under the New Situation of High-Level Talent Training—Taking Guangxi Medical University as an Example. *Guangxi Economy*, 41(06): 167–172.
- [10] Yang L, Wang L, Yang L, et al., 2020, Constructing a Student Teaching Information Feedback and Processing System to Improve the University Teaching Quality Monitoring System. *Medical Education Management*, 6(1): 1–5.
- [11] Ni L, 2020, Giving Play to the Role of Student Monitor of Instruction to Improve the Teaching Quality Monitoring System. *China Journal of Multimedia & Network Teaching*, 2020(4): 94–95.
- [12] Li B, Liu H, 2020, Research on the Important Role of Student Monitor of Instruction Management in Teaching Quality Assurance in Private Universities—Taking Guangxi University of Foreign Languages as an Example. *Strait Science and Technology and Industry*, 2020(10): 14–17.
- [13] Zhang M, Guo Y, 2025, Innovative Approaches and Role Play of the Construction of Student Monitor of Instruction Teams in Universities in the New Era—Taking the School of Food Engineering of Heilongjiang East University as an Example. *Journal of Hubei Open Vocational College*, 38(09): 30–32.
- [14] Wu W, Sun W, Wang H, 2023, Research on the Development Path and Effectiveness of the University Student Monitor of Instruction System under the OBE Concept. *2023 Collection of Papers on Teaching Method Innovation and Practical Scientific Research*, Working Committee of the International Academician Consortium of China International Association for the Promotion of Science and Technology, Beijing, 219–221.
- [15] Han J, Zheng X, 2024, Dilemmas and Construction Paths of the University Student Information Assistant System under the Background of Informatization. *University Education*, 2024(5): 6–9.

Publisher's note

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

Research on Innovative Paths of Class Talent Management by Counselors in Higher Vocational Colleges in the New Era

Ke Mao*

Private Hualian College, Guangzhou 510663, Guangdong, China

**Author to whom correspondence should be addressed.*

Copyright: © 2025 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: Under the background of the new era, vocational education has ushered in a strategic upgrade with the positioning of “type education.” As the main position for cultivating technical and skilled talents, higher vocational colleges are facing new challenges in talent management, such as the diverse personalities of Generation Z students, the accelerated digital transformation, and the deepened requirements of “all-staff, whole-process, and all-round education.” Based on the fundamental task of fostering morality and cultivating people, combined with the school-running characteristics of higher vocational colleges of “practice orientation and integration of production and education,” this paper explores the innovative paths of talent management by counselors from four dimensions: concept reshaping, mechanism coordination, method innovation, and team empowerment. The purpose is to improve the efficiency of talent management and help cultivate high-quality technical and skilled talents with “both moral integrity and professional skills, and integration of work and study.”

Keywords: Higher vocational colleges; Counselors; Talent management

Online publication: November 14, 2025

1. Introduction

Counselors are the “first responsible persons” for ideological education in the process of talent cultivation in higher vocational colleges. Class management, as the core carrier of counselors’ work in colleges and universities, is directly related to the quality of talent cultivation and campus stability. The report to the 20th National Congress of the Communist Party of China clearly proposes to “coordinate the collaborative innovation of vocational education, higher education, and continuing education, and promote the integration of vocational and general education, the integration of production and education, and the integration of science and education,” pointing out the direction for the development of higher vocational education in the new era. The “National Vocational Education Reform Implementation Plan” also emphasizes “strengthening ideological and political education in higher vocational colleges and improving the mechanism for building counselor teams”^[1]. However,

the current talent management of classes by counselors in higher vocational colleges still has problems such as the solidification of “management-oriented” thinking, insufficient application of digital tools, loose collaborative education mechanisms, and lagging response to students’ personalized needs^[2]. Therefore, exploring innovative paths of class talent management that meet the requirements of the new era and highlight the characteristics of higher vocational education has become an important issue that needs to be solved urgently.

2. Practical challenges of talent management by counselors in higher vocational colleges in the new era

The new era endows higher vocational education with new missions, and also makes talent management face multiple challenges, mainly reflected in the following three aspects.

2.1. Student level: Impact of Generation Z’s characteristics and diversified needs

Higher vocational students are mainly composed of “Generation Z,” showing distinct characteristics of the times:

- (1) Diverse values: Affected by the fragmentation of online information, some students have low recognition of vocational education and suffer from “academic anxiety” and “employment confusion,” so ideological and political education needs to be more targeted.
- (2) Normalization of digital survival: Students are used to obtaining information through short videos and social platforms, but their ability to distinguish information is insufficient, making them vulnerable to the influence of harmful ideological trends.
- (3) Complex student source structure: In addition to general high school graduates, the proportion of “non-traditional students” such as secondary vocational students, veterans, and migrant workers is increasing. Different student sources have significant differences in knowledge foundation, career planning, and behavioral habits, putting forward higher requirements for personalized talent management^[3].

2.2. Management level: Disconnection between traditional models and higher vocational characteristics

- (1) Serious “transactional” tendency: Counselors need to undertake a large number of transactional tasks, such as attendance checking, evaluation of excellent students, financial assistance, and safety, which occupy the time for ideological and political guidance and in-depth education, leading to management that “emphasizes process over effect.”
- (2) Outdated methods and means: They still rely on traditional methods such as “holding meetings for publicity, checking dormitories and roll calls, and filling out paper forms.” The application of digital tools only stays at the level of “information release,” failing to realize dynamic monitoring and precise intervention of students’ behavior, academic performance, and psychology.
- (3) Disconnection from professional training: Class talent management lacks linkage with professional training, integration of production and education, and career planning. It fails to integrate “craftsmanship spirit” and “model worker spirit” into daily management, making it difficult to meet the educational goal of “integration of work and study” in higher vocational education^[4].

2.3. External level: Insufficient policy requirements and resource coordination

- (1) Difficulty in implementing “all-staff, whole-process, and all-round education”: The enthusiasm of

departments, professional teachers, enterprise mentors, parents, and other subjects to participate in class talent management is insufficient, and the educational synergy of “all-staff, whole-process, and all-round” has not yet been formed ^[5].

- (2) Pressure of digital transformation: Although the construction of smart campuses has been generally promoted, the functions of class talent management modules are scattered (such as attendance systems, psychological evaluation systems, and academic early warning systems are not connected), and the value of data has not been fully explored.
- (3) Higher employment-oriented requirements: Higher vocational education is employment-oriented, but links such as career planning guidance, industry dynamics transmission, and enterprise resource connection in class management are weak, failing to effectively help students’ career development.

3. Innovative paths of talent management by counselors in higher vocational colleges in the new era

In response to the above challenges, it is necessary to build an innovative path from four dimensions: concept, mechanism, method, and team, based on “student-centered, fostering morality and cultivating people as the fundamental, and higher vocational characteristics as the support.”

3.1. Concept reshaping: Transformation from “management-oriented” to “service-leadership-oriented”

Concept is the soul of management. Class management in the new era needs to break through the “control thinking” and establish three core concepts:

- (1) “Student-oriented” service concept: Shift the focus of management from “restricting behavior” to “meeting needs”, focus on the four major needs of students: “academic development, career planning, mental health, and life services”, and establish personalized growth files of “one student, one file”^[6]. Strengthen basic subject tutoring for secondary vocational students, provide vocational skill connection support for veterans, and guide the cultivation of practical abilities for general high school graduates.
- (2) “Integration of moral integrity and professional skills” concept: Closely follow the dual main lines of “technical skills + ideological and political education” in higher vocational education, and deeply integrate class talent management with professional education. For example, form “skill competition groups” based on classes, counselors cooperate with professional teachers to connect with enterprise projects, and infiltrate “quality awareness” and “safety awareness” in training; carry out “model workers entering classes” activities, invite industry craftsmen to share their career experiences, and cultivate students’ craftsmanship spirit.
- (3) “Student autonomy” democratic concept: Break the “counselor-led” model and build a class autonomy system of “counselor guidance + student backbone leadership + full participation”. Through methods such as “class councils” and “online voting”^[7], let students independently formulate class rules, organize activities, and manage affairs. For example, students are responsible for the operation of the class official WeChat account to spread professional dynamics and positive energy, and enhance class sense of belonging.

3.2. Mechanism coordination: Building a “five-in-one” collaborative education system

Relying on the requirements of “all-staff, whole-process, and all-round education”, integrate multiple resources, and establish a “five-in-one” collaborative mechanism of “counselors + professional teachers + enterprise mentors + student backbones + parents” to form educational synergy, as shown in **Table 1**.

Table 1. Summary of the “five-in-one” collaborative mechanism

| Collaborative subjects | Core responsibilities | Collaborative paths |
|------------------------|--|---|
| Counselors | Overall coordination, ideological and political guidance, psychological counseling, daily management | Hold regular collaborative meetings to summarize students’ situations; build an online collaborative platform to share students’ growth files |
| Professional teachers | Academic guidance, professional ideological and political education, skill training | Design “curriculum ideological and political” theme class meetings combined with course content; participate in the guidance of class skill competitions |
| Enterprise mentors | Career planning, industry dynamics, practical guidance | Carry out “enterprise open day” activities; provide internship and employment recommendations for students; participate in class career planning lectures |
| Student backbones | Class autonomy, information transmission, activity organization | Take the lead in setting up study groups and cultural and sports groups; assist counselors in handling transactional work; feedback students’ needs |
| Parents | Family support, concept guidance, home-school communication | Establish a parent WeChat group to regularly push students’ study and life situations; invite parents to participate in “parent open day” activities |

Through this mechanism, the predicament of “counselors fighting alone” is broken, and the organic integration of “ideological and political education, professional education, vocational education, and family education” is realized. For example, through “five-in-one collaboration”, a mechanical and electrical professional class in a higher vocational college organized students to participate in enterprise production line training. Professional teachers were responsible for technical guidance, enterprise mentors explained post specifications, counselors simultaneously carried out ideological and political education on “labor spirit”, and parents witnessed students’ practical achievements through video calls, which significantly improved students’ professional identity and class cohesion.

3.3. Method innovation: Digital empowerment of smart class talent management

Leverage digital transformation to build an “online + offline” integrated smart class talent management model, and improve management accuracy and efficiency:

- (1) Build a smart class talent management platform: Integrate functions such as attendance checking, leave application, academic early warning, psychological monitoring, and information release to realize “one-time data collection and multi-terminal sharing”^[8]. For example, automatically count students’ class attendance rate through the platform, trigger “academic early warning” for students who are absent continuously, and counselors intervene in a timely manner, combined with feedback from professional teachers; use the psychological evaluation module to regularly monitor students’ psychological status, and automatically remind counselors to intervene for risk signals such as depression and anxiety.
- (2) Use new media to innovate ideological and political carriers: According to the preferences of Generation Z students, build a new media matrix such as “class short video accounts” and “WeChat official accounts,” and push content such as “craftsman stories,” “professional frontiers,” and “Party history

learning.” For example, shoot a series of short videos of “My Enterprise Learning Vlog” to let students share their practical experiences in enterprises, and implicitly convey professional spirit; carry out “online theme class meetings” to improve the participation of ideological and political education through bullet screen interaction and voice connection sharing.

- (3) Big data-driven precise education: Construct students’ “growth portraits” by analyzing data from smart platforms (such as learning time, training performance, social interaction, consumption habits, etc.)^[9,10]. For example, for students with “excellent training performance but weak theoretical scores”, coordinate professional teachers to provide personalized tutoring; for students who “frequently browse content related to employment anxiety”, carry out one-on-one career planning guidance in conjunction with enterprise mentors to realize precise management of “one policy for thousands of people.”

3.4. Team empowerment: Improving counselors’ “dual-qualified” management capabilities

The counselor team is the core support for the innovation of class talent management. It is necessary to improve their comprehensive capabilities of “ideological and political + professional + management” around the characteristics of higher vocational education:

- (1) Strengthen the cultivation of “dual-qualified” literacy: Incorporate counselors into the “dual-qualified” teacher training system of higher vocational colleges^[11,12], encourage counselors to obtain industry vocational qualification certificates (such as psychological counselors, career guidance teachers, professional-related skill certificates), and participate in enterprise practice training, so that they can not only carry out ideological and political education, but also understand professional training goals and connect with industry needs.
- (2) Establish special training and teaching research mechanisms: Regularly carry out special training on “innovation of class talent management in higher vocational colleges,” “application of digital tools,” and “psychological crisis intervention”; set up a “class talent management teaching and research group” for counselors^[13,14], carry out discussions on topics such as “management of non-traditional students” and “design of class activities integrating production and education,” and summarize and promote excellent cases.
- (3) Improve the assessment and incentive mechanism: Optimize the counselor assessment indicators, include “collaborative education effectiveness,” “application of digital management,” and “quality of students’ career development” into the assessment, and commend and reward counselors with outstanding innovations in class talent management to stimulate their innovation motivation.

4. Conclusion

The innovation of class talent management by counselors in higher vocational colleges in the new era is an inevitable requirement to respond to the reform of vocational education, meet the diverse needs of students, and improve the quality of education. By “reshaping concepts” to establish a service-leadership orientation, “coordinating mechanisms” to integrate multiple educational resources, “innovating methods” to leverage digital empowerment, and “empowering teams” to strengthen counselors’ comprehensive literacy, a new class talent management model that fits the characteristics of higher vocational education and highlights the characteristics of the times can be built^[15]. In the future, it is necessary to further combine the practice of specific colleges and

universities, continuously optimize the innovative paths, and make class talent management truly an important carrier of “fostering morality and cultivating people and skill training”, providing a solid guarantee for cultivating more high-quality technical and skilled talents with “both moral integrity and professional skills”.

Funding

2024 Higher Vocational Education Teaching Reform Research and Practice Project (Project No.: GDGX202401166)

Disclosure statement

The author declares no conflict of interest.

References

- [1] State Council, 2019, National Vocational Education Reform Implementation Plan.
- [2] Du T, Guo J, 2021, Exploration on the Work Path of Class Management by College Class Teachers. *University*, 2021(46): 57–59.
- [3] Zhang L, 2022, Analysis of Innovative Paths of Class Management by Counselors in Higher Vocational Colleges in the New Era. *Vocational and Technical Education*, 43(26): 68–72.
- [4] Guli L, 2022, Thoughts on the Work of College Class Teachers in the New Period. *Modern Vocational Education*, 2022(05): 178–180.
- [5] Liu Y, Jiang J, 2023, Exploration and Reflection on the Work of Class Teachers Based on the Concept of “All-staff, Whole-process, and All-round Education”. *Modern Vocational Education*, 2023(01): 113–116.
- [6] Li J, 2021, Research on the Collaborative Management Mechanism of Classes from the Perspective of “All-staff, Whole-process, and All-round Education” in Higher Vocational Colleges. *Vocational Education Research*, 2021(11): 78–82.
- [7] Cui Y, 2021, Construction of Analysis Framework and Ideas for the Work of Class Teachers in Higher Vocational Colleges. *Modern Vocational Education*, 2021(23): 220–221.
- [8] Huang T, 2020, A Probe into Class Management in Higher Vocational Colleges under the Background of the New Era. *Industry and Technology Forum*, 2020(10): 3.
- [9] Chen Y, 2022, Research on Innovative Paths of Class Management by Counselors in Higher Vocational Colleges. *Silk Road Vision*, 2022(28): 55–57.
- [10] Xu X, 2023, Innovative Paths of Class Management by Counselors in Higher Vocational Colleges from the Perspective of Great Ideological and Political Education. 2023 Ideological and Political Education Forum, Jiangxi Industry and Trade Vocational and Technical College, 2023.
- [11] Liu J, Lian X, 2023, Innovating the Class Management Work of Secondary Vocational Class Teachers by Using Modern Information Technology. *China New Communications*, 2023(18): 171–173.
- [12] Zeng M, 2022, Research on Ideological and Political Work of College Class Teachers from the Perspective of “All-staff, Whole-process, and All-round Education”—Based on a Survey of Law and Business College of Hubei University of Economics. *Journal of Hubei University of Economics (Humanities and Social Sciences Edition)*, 2022(03): 125–127.

- [13] Xing Q, Nie R, 2022, Research on the Collaborative Education Work between College Counselors and New-type Class Teachers Based on the Concept of “All-staff, Whole-process, and All-round Education”. *Economic Research Guide*, 2022(05): 86–88.
- [14] Wang J, 2023, Construction of Smart Class Management Model in Higher Vocational Colleges under the Background of Digital Transformation. *Chinese Vocational and Technical Education*, 2023(15): 85–89.
- [15] Liu T, 2021, Discussion on the Application of Information Technology in the Management Work of Secondary Vocational Class Teachers. *Journal of Jiamusi Vocational Institute*, 2021(05): 157–158.

Publisher's note

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

Research on Improving the Efficiency of University Campus Facilities Resource Allocation Based on Data-driven

Qinglin Feng*

Jiangsu University, Zhenjiang 212013, Jiangsu, China

**Author to whom correspondence should be addressed.*

Copyright: © 2025 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: With the expansion of the scale and the complexity of the functions of colleges and universities, the efficiency and accuracy of the allocation of fire safety facilities resources have become the key to ensure campus safety. Aiming at the problems of aging facilities, uneven distribution of resources and lagging emergency response in traditional fire management mode, this paper puts forward a data-driven optimization framework for resource allocation of fire safety facilities in colleges and universities. Real-time collection of facility operation data through Internet of Things sensors, combined with big data analysis and machine learning algorithms, establishes risk assessment, facility performance attenuation prediction and dynamic resource allocation models to achieve accurate allocation and efficient utilization of resources.

Keywords: Data-driven; Fire-fighting in colleges and universities; Resource allocation; Dynamic optimization

Online publication: November 14, 2025

1. Introduction

As a densely populated and functionally complex public place, the allocation of fire safety facilities in colleges and universities is directly related to the safety of the lives and property of teachers and students and the stability of the campus. The traditional fire management model, which relies on manual inspection and experience-based decision-making, has problems such as aging facilities, lagging maintenance, unbalanced resource allocation, and insufficient timeliness of emergency response, making it difficult to dynamically control fire hazards and limiting the overall safety level. With the development of Internet of Things, big data and artificial intelligence technologies, the data-driven management model provides new ideas for the allocation of fire safety facility resources. By perceiving the status of facilities in real time, predicting risk trends, and optimizing resource scheduling, a shift from “passive response” to “active prevention and control” can be achieved, enhancing the scientific and refined level of campus fire safety management.

2. Analysis of the current situation and problems in the allocation of fire safety facilities resources on university campuses

2.1. Current situation of allocation of fire safety facilities in colleges and universities

As densely populated and functionally complex public places, the allocation of fire safety facilities in colleges and universities is directly related to campus safety and stability. At present, fire safety facilities in colleges and universities mainly include fire-fighting equipment (such as fire extinguishers, fire hydrants), alarm systems (such as smoke detectors, temperature detectors), sprinkler systems, and emergency lighting and evacuation indication systems, etc. The distribution of these facilities shows obvious regional differences. They are densely distributed in key areas such as dormitories, laboratories and canteens, while they are relatively sparse in general teaching areas and public areas ^[1].

2.1.1. Fire-fighting equipment configuration

Fire-fighting equipment is the foundation of fire safety in colleges and universities. The quantity and types of fire-fighting equipment should be determined comprehensively based on factors such as the nature of use of the building, the fire hazard and the difficulty of evacuation. For example, more dry powder fire extinguishers and carbon dioxide fire extinguishers are needed in laboratories where a large number of flammable and explosive items are stored; In the dormitory area, water-based fire extinguishers should be given priority, and there should be an adequate number of fire extinguishers available on each floor and in common areas.

Table 1. Data on the current configuration of fire safety facilities in colleges and universities

| Area/Facility type | Number of fire-fighting equipment (units/square meters) | Alarm system coverage (%) | Coverage rate of sprinkler devices (%) | Facility aging rate (%) |
|-----------------------|--|------------------------------|---|----------------------------|
| Dormitory area | 12.35 | 98.23 | 92.56 | 18.75 |
| Laboratory | 18.67 | 96.89 | 89.45 | 22.34 |
| Cafeteria | 9.87 | 95.67 | 87.32 | 15.68 |
| General teaching area | 6.54 | 89.12 | 78.90 | 12.45 |
| Public areas | 4.32 | 85.67 | 72.34 | 10.21 |

The aging rate data in **Table 1** shows that the aging problem of facilities in the dormitory area and laboratories is more prominent, which may be related to the high frequency of use and heavy load of facilities in these areas. Facility aging affects fire performance and may also increase the risk of fire.

2.1.2. Alarm systems and sprinkler systems

At present, colleges and universities commonly use a combination of smoke detectors and temperature detectors to achieve early detection of fires; Sprinkler systems, as an important component of automatic fire extinguishing systems, are widely used in important places such as libraries and computer rooms, while some old buildings, due to their long construction time, have problems such as reduced sensitivity of alarm systems and incomplete coverage of sprinkler systems ^[2].

2.1.3. Coverage areas and differentiated configurations of facilities

The dormitory area, as a densely populated area, needs to focus on strengthening the inspection of fire escape accessibility and the provision of fire-fighting equipment; Laboratories should strictly control the storage of flammable

and explosive items and be equipped with professional fire-fighting facilities and emergency plans; Dining places such as canteens need to pay attention to issues such as the cleaning of fume ducts and the detection of gas leaks ^[3].

Table 2. Facility coverage and differentiation

| Resource types | Investment in high-risk areas (ten thousand yuan per year) | Investment in low-risk areas (ten thousand yuan per year) | Input ratio (high: low) |
|-------------------------|---|--|----------------------------|
| Fire-fighting equipment | 45.67 | 12.34 | 3.70:1 |
| Maintenance costs | 32.18 | 8.76 | 3.67:1 |
| Emergency drills | 9.80 | 2.15 | 4.56:1 |

2.2. Existing problems and bottlenecks in resource allocation efficiency

Although universities have achieved certain results in the allocation of fire safety facilities, there are still many problems that restrict the improvement of resource allocation efficiency.

2.2.1. Aging facilities and lagging maintenance

Some fire protection facilities have aged over time and their performance has declined significantly. For example, problems such as insufficient fire extinguisher pressure, rising false alarm rate of the alarm system, clogging of the sprinkler system occur frequently, and due to insufficient maintenance funds, low professional quality of maintenance personnel and other reasons, facility maintenance often lags behind actual needs, resulting in increased fire hazards ^[4].

2.2.2. Uneven distribution of resources

There is a significant imbalance in the allocation of fire safety facilities among different areas within colleges and universities. There is a prominent contradiction in the allocation of resources between high-risk areas (such as laboratories and student dormitories) and low-risk areas (such as general teaching areas). Some universities focus too much on fire safety investment in key areas and neglect the daily management and maintenance of low-risk areas, resulting in limited improvement of the overall fire safety level ^[5].

2.2.3. Inadequate timeliness and accuracy of emergency response

Under the traditional fire management model, the problems of delayed resource scheduling and inefficient information transmission have severely restricted the speed of emergency response. When a fire breaks out, the fire department often has to spend a lot of time confirming the fire situation, allocating resources and rushing to the scene, resulting in the loss of the best time to put out the fire. Problems such as misjudgment and the spread of panic may also arise due to inaccurate or untimely information transmission ^[6].

Table 3. Data on the timeliness of fire emergency response in colleges and universities

| Response links | Average response time (minutes) | Standard deviation (minutes) |
|---------------------|---------------------------------|------------------------------|
| Fire confirmation | 8.45 | 2.10 |
| Resource allocation | 12.67 | 3.45 |
| On-site arrival | 20.32 | 5.67 |
| Total response time | 41.44 | 7.89 |

The data in **Table 3** shows that the average response time of university fire departments in areas such as fire confirmation, resource allocation, and on-site arrival is longer and more volatile. This may be related to the inefficient information transmission and delayed resource dispatch under the traditional fire management model. Improving the timeliness of emergency response is crucial for reducing fire losses ^[7].

3. A data-driven framework for optimizing the allocation of fire safety facilities resources in colleges and universities

In response to the above issues, this paper proposes a data-driven framework for optimizing the allocation of fire safety facilities resources in colleges and universities, aiming to achieve precise allocation and efficient utilization of fire safety facilities resources through measures such as multi-source data collection and integration, data analysis and model construction, and evaluation of resource allocation efficiency.

3.1. Data collection and integration mechanism

3.1.1. Multi-source data collection technology system

Establishing a multi-source data acquisition technology system is the foundation of data-driven resource allocation. Real-time monitoring and data collection of the operational status of fire protection facilities through Internet of Things sensors (such as smoke sensors, temperature sensors, power consumption monitoring sensors, etc.); At the same time, integrate fire protection system logs, historical accident data and external environmental data (such as meteorological data, personnel flow data, etc.) to form a comprehensive and accurate data source ^[8].

3.1.2. Data standardization and cleaning processes

To ensure data quality and consistency, a unified data interface and format specification should be established. Convert data from different sources and in different formats into a unified format through data standardization processing; At the same time, outlier detection and missing data completion methods are used to clean and preprocess the collected data to eliminate noise interference and data missing issues ^[9].

3.2. Data analysis and resource allocation model construction

3.2.1. Risk assessment model based on big data

Building risk assessment models using big data technology is key to improving the accuracy of resource allocation. Deep mining and analysis of historical fire data through algorithms such as cluster analysis and association rule mining to identify fire hazard points and high-risk areas. In addition to real-time monitoring data and external environmental data, the risk assessment results are dynamically adjusted to provide a scientific basis for resource allocation.

3.2.2. Facility performance degradation prediction model

Aiming at the aging problem of fire protection facilities, a prediction model for facility performance attenuation based on time series analysis is established. By analyzing historical maintenance records and performance test data, predict the future performance change trend of the facility. When the performance of the facility drops to a preset threshold, the maintenance warning mechanism is automatically triggered to guide managers to carry out repairs or replacements in a timely manner ^[10].

3.2.3. Dynamic resource allocation decision model

To achieve dynamic allocation and efficient utilization of fire safety facility resources, a dynamic resource allocation decision model needs to be constructed. The model is based on regional resource demand estimation and resource scheduling optimization strategies supported by machine learning algorithms, and automatically generates the optimal resource allocation plan based on real-time risk assessment results and resource availability. While taking into account the coordination issues in the emergency response process, it ensures timely and accurate resource scheduling.

3.3. Evaluation index system for resource allocation efficiency

To comprehensively assess the efficiency of resource allocation of fire safety facilities in colleges and universities driven by data, a scientific and reasonable evaluation index system needs to be established. The system includes multiple dimensions such as facility availability indicators (such as failure rate, maintenance timeliness rate), emergency response efficiency indicators (such as early warning response time, resource arrival time), and resource utilization balance indicators (such as regional coverage, input-output ratio in high-risk areas). By collecting and analyzing relevant data on a regular basis, the efficiency of resource allocation is objectively evaluated and continuously improved ^[11].

4. Empirical research and validation of data-driven resource allocation

To verify the effectiveness of the data-driven framework for optimizing the allocation of fire safety facilities resources in colleges and universities, this paper selects a Vocational College as the empirical research object and constructs the empirical research environment through measures such as deploying Internet of Things devices, integrating historical accident data and simulated fire scenarios. At the same time, a comprehensive assessment of the optimization effect was conducted from three aspects: improvement of facility maintenance efficiency, improvement of emergency response timeliness, and optimization of resource allocation balance.

3.1. Case selection and data basis

A vocational college, as a comprehensive higher vocational college, has a vast campus with diverse buildings and faces significant challenges in fire safety management. The college's original fire protection facilities are relatively old and unevenly distributed, with many potential safety hazards. To improve this situation, the college has decided to introduce a data-driven framework for optimizing the allocation of fire safety facilities resources in colleges and universities. During the empirical research, a large number of Internet of Things sensors (such as smoke sensors, temperature sensors, etc.) were first deployed within the college to achieve real-time monitoring and data collection of the operating status of fire protection facilities. At the same time, data on fire accidents that occurred in the college in recent years and log data of the fire protection system were integrated to provide data support for the construction of the risk assessment model; In addition, a variety of fire scenarios were simulated to verify the effectiveness of the dynamic resource allocation decision model ^[12].

4.2. Analysis of the effects of resource allocation optimization

4.2.1. Improvement in facility maintenance efficiency

By introducing a predictive maintenance mechanism, the failure rate of the college's fire protection facilities has been significantly reduced (**Table 4**). The system arranges maintenance plans in advance and allocates

maintenance resources based on the results of the facility performance degradation prediction model. At the same time, mobile terminal devices are used for online dispatch and progress tracking of maintenance tasks to ensure the timely and effective completion of maintenance work. According to statistics, after implementing the data-driven resource allocation optimization framework, the average failure rate of the college's fire protection facilities decreased by approximately 30%, and the maintenance timeliness rate increased by approximately 25% ^[13].

Table 4. Data on improvements in facility maintenance efficiency

| Metrics | Pre-optimization data | Post-optimized data | Rate of change (%) |
|--|-----------------------|---------------------|--------------------|
| Average failure rate of fire protection facilities (times/month) | 12.45 | 8.72 | -30.00 |
| Timely completion rate of maintenance tasks (%) | 72.34 | 97.56 | +25.22 |
| Maintenance resource allocation time (hours per time) | 3.25 | 1.87 | -42.46 |

4.2.2. Improvements in emergency response timeliness

The application of dynamic resource allocation decision-making models has significantly improved the speed of emergency response (Table 5). When a fire occurs, the system can quickly generate the optimal resource allocation plan based on real-time risk assessment results and resource availability. At the same time, resources are quickly allocated and delivered to the scene through intelligent scheduling algorithms. According to actual test data, after implementing the optimization framework, the average time from the issuance of the early warning to the arrival of resources was reduced by about 40 seconds (second-level response verification), winning valuable time for the initial control of the fire ^[14].

Table 5. Data on improvements in emergency response timeliness

| Indicators | Pre-optimization time (seconds) | Post-optimization time (seconds) | Shorten time (seconds) |
|---|---------------------------------|----------------------------------|------------------------|
| The average time from the issuance of the warning to the arrival of resources at the site | 125.67 | 85.23 | 40.44 |
| Fire confirmation time | 18.45 | 9.87 | 8.58 |
| Resource allocation time | 42.32 | 25.67 | 16.65 |

4.2.3. Optimization of resource allocation balance

By introducing a big data-based risk assessment model and a dynamic resource allocation decision model, the allocation balance of fire safety facilities resources in the college has been significantly improved. The system precisely allocates resources based on the functional characteristics and fire risk levels of different areas. At the same time, increase investment and optimize facility layout for high-risk areas such as laboratories and student dormitories. According to the assessment results, resource input in high-risk areas increased by about 15% after the implementation of the optimization framework, while redundant resources in low-risk areas decreased by about 10%; Overall resource utilization efficiency has been significantly improved ^[15].

4.3. User feedback and system adaptability assessment

In order to comprehensively assess the user satisfaction and system adaptability of the data-driven framework for optimizing the allocation of fire safety facilities in colleges and universities, this paper also conducts user feedback surveys and system scalability tests.

4.3.1. Evaluation of ease of operation for administrators

Through interviews and questionnaires with personnel from the college's fire management department, it was found that managers gave high praise for the ease of operation of the system. The system has a user-friendly interface, excellent data visualization, and complete functions. Managers can easily complete tasks such as data query, risk assessment and resource allocation. The system also provides detailed operation guides and online help functions, further lowering the threshold for use.

4.3.2. Enhanced fire safety awareness among teachers and students

With the extensive application of smart fire protection systems and the in-depth implementation of publicity and education, the fire safety awareness of teachers and students in the college has been significantly enhanced. According to the results of the questionnaire survey, more than 90 percent of teachers and students said they had a deeper understanding of fire safety knowledge. At the same time, more than 80 percent of teachers and students said they could quickly take the right self-rescue measures and assist others in evacuating when a fire broke out. In addition, the early warning information reach rate and the participation in emergency drills have also increased, laying a solid foundation for building a safe campus ^[16].

5. System scalability and cross-scenario applicability

This paper also conducts multi-scenario tests to verify the scalability and cross-scenario applicability of the system. By migrating the system to other universities of similar or different sizes for application testing, it was found that the system could quickly adapt to the new environment and operate stably. The system's functionality was further refined and enhanced after customized development for specific requirements in different scenarios. This indicates that the data-driven framework for optimizing the allocation of fire safety facilities resources in colleges and universities has broad promotional value and application prospects.

6. Conclusion

This paper presents a data-driven framework for optimizing the allocation of fire safety facilities resources in colleges and universities, which integrates Internet of Things, big data and machine learning technologies to achieve real-time monitoring of facility status, dynamic risk assessment and precise allocation of resources. Empirical research shows that the framework can significantly improve facility maintenance efficiency, emergency response speed and resource allocation balance, while reducing human management errors and enhancing the initiative and systematicness of campus fire safety management. The study provides replicable optimization paths for the configuration of fire facilities in colleges and universities and theoretical references for data-driven decision-making in the field of public safety.

Disclosure statement

The author declares no conflict of interest.

References

- [1] Yang Y, Zheng C, Liu C, et al., 2020, Construction and Optimization Strategies of Interactive and Management

- Systems for Teaching Spaces in Colleges and Universities Driven by Internet of Things. *Internet of Things Technology*, 15(20): 157–162.
- [2] Li H, 2025, Innovation and Practice of Library Space Services in the Context of Smart Campus. *Shen Hua*, 2025(30): 99–101.
 - [3] Sun L, 2025, Research on the Construction of Smart Fire Safety Early Warning System in Colleges and Universities Driven by Big Data. *Fire Journal (Electronic Edition)*, 11(01): 13–15.
 - [4] Li J, 2024, Research on the Behavioral Intention Influence Mechanism of Data-Driven University Management Decisions, thesis, China University of Mining and Technology.
 - [5] Guo Y, 2024, Research on the Misconceptions and Transformation Strategies of Big Data-Driven High-Quality Regional Education Development, thesis, Anhui Normal University.
 - [6] Chen M, 2023, Research on Precise Ideological and Political Education in Colleges and Universities in the Era of Big Data, thesis, Hunan University.
 - [7] Chen Z, 2020, Research on Building Energy Efficiency Management Based on Data-Driven, thesis, Chongqing University.
 - [8] Yi L, Zou T, 2019, Research on Safe Campus Construction in Colleges and Universities Driven by Big Data. *China Educational Technology*, 2019(08): 57–62.
 - [9] Hu Y, Bai X, Su X, et al., 2025, Research on the Current Situation and Countermeasures of Safety Emergency Facilities in University Campuses. *China Equipment Engineering*, 2025(14): 253–255.
 - [10] Yan J, 2025, Research on the Balance Between Campus Openness and Campus Security Management. *Contemporary Manager*, 2025(02): 84–92.
 - [11] Liu S, Zhang X, 2020, Research on Spatial Optimization of Public Service Facilities in University Campuses Based on the Concept of Life Circle: A Case Study of Wuhan University. *Industrial Buildings*, 55(04): 1–8.
 - [12] Chen B, Chen T, Feng X, 2025, Research on the Construction of Conservation-Oriented Campus in Colleges and Universities in an Informationized Environment. *Society and Public Welfare*, 2025(10): 229–231.
 - [13] Yu X, 2025, Research on Design Strategies for the Renewal of Old University Campuses Based on CRS Architectural Planning Theory, thesis, Anhui Jianzhu University.
 - [14] Zhang C, 2025, Research on Evaluation and Optimization Strategies of Public Facilities in Outdoor Spaces of Universities Based on KANO-QFD, thesis, Qingdao University of Technology.
 - [15] Jiang Q, Wu B, Zhao Y, et al., 2024, A Review of University Campus Planning from the Perspective of Green Infrastructure. *Journal of Ningbo University of Technology and Technology*, 36(04): 73–80.
 - [16] Wei L, 2024, Research on Modular Design of Public Facilities in Colleges and Universities Under Low-Cost Orientation. *Packaging & Design*, 2024(06): 194–195.

Publisher's note

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

Research on the Structural Characteristics and Optimization Paths of Residents' Elderly Care Consumption Behavior Under the Background of Population Aging

Yuyang Wu, Haiyao Ji, Nisirela Nuraili, Yaru Li, Minxue Zou*

Changji College, Changji 831100, Xinjiang, China

**Author to whom correspondence should be addressed.*

Copyright: © 2025 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: The “national strategy for actively responding to population aging” has been elevated to a new height. Against this background, an in-depth exploration of residents’ elderly care consumption behavior is crucial for improving the elderly care security system. Based on a questionnaire survey of 727 residents and using cross-analysis methods, this study systematically examines the structural characteristics and influencing factors of residents’ elderly care consumption. The research finds that residents’ cognition of elderly care consumption presents a “reality-expectation” dual structure: current consumption is dominated by “subsistence-oriented” expenditures such as medical care and daily living, while future expectations are significantly inclined to “development-oriented” consumption such as culture and entertainment. The quality of elderly care services is a core pain point, and residents have a strong willingness to improve, which is also significantly related to their living status. There is a strong correlation between policy awareness and payment willingness—groups with high awareness have a high willingness to pay, a phenomenon that reveals the market activation effect of policy communication. At the same time, residents’ access to elderly care-related information is highly dependent on informal networks, with a high proportion of recommendations from acquaintances, reflecting the lack of professional information niches. Accordingly, this paper proposes that efforts should be made synergistically from four aspects: supply-side reform, precise policy communication, full-cycle elderly care planning education, and information platform construction, to promote the high-quality development of the elderly care consumption market through systematic paths.

Keywords: Population aging; Elderly care consumption; Structural characteristics; Policy awareness; Optimization paths

Online publication: November 14, 2025

1. Introduction

With the continuous deepening of China’s population aging process and the miniaturization of family structures, building an elderly care service system compatible with the level of economic and social development has

become a major people's livelihoods. "Developing elderly care undertakings and industries, and promoting the realization of basic elderly care services for all elderly people" provides fundamental guidelines for addressing the challenges of aging. Under this strategic guidance, residents' elderly care consumption behavior, as a key node connecting macro policies and micro well-being, its form and trends are directly related to the effectiveness of elderly care policies and the direction of the elderly care industry.

Existing research on elderly care consumption mostly focuses on the macro institutional level or single consumption phenomena. Mu et al. (2023) ^[1] systematically discussed the long-term trends of population aging and its overall challenges to the social security system, but paid little attention to the micro-level response mechanisms of residents' behavior. Although Zheng (2022) ^[2] conducted an in-depth study on the institutional path of pension reform, he did not fully reveal the specific connection between pension levels and residents' daily consumption choices. At the same time, some studies have begun to pay attention to emerging forms of elderly care consumption, such as Wang et al. (2023) ^[3] who discussed new models like "travel elderly care," but failed to systematically analyze the coexistence and tension between "subsistence-oriented" and "development-oriented" consumption in residents' elderly care planning from the perspective of overall consumption structure changes.

In view of this, this study aims to break the research gap between macro and micro, institutions and behaviors. The core research questions are: Under the current policy and social environment, what deep-seated structural characteristics do Chinese residents' elderly care consumption behaviors present? What key factors affect these characteristics? To answer these questions, this study attempts to depict residents' cognition, budget, decision-making logic, and demand preferences of elderly care consumption through an empirical survey of 727 residents nationwide, in order to provide an academic basis and decision-making reference for building a multi-level elderly care security system with a more agile response and more precise supply.

2. Literature review and analytical framework

2.1. Multiple perspectives of elderly care consumption research

Existing research on elderly care consumption can be roughly summarized into three perspectives: the first is the "policy-institution" perspective, which focuses on the bottom-line support and redistribution effect of public policies such as endowment insurance and long-term care insurance on residents' elderly care payments ^[2]. The second is the "industry-market" perspective, which focuses on the format innovation, market segmentation and business models of elderly care service supply, such as smart elderly care and the integration of medical and elderly care ^[3]. The third is the "individual-family" perspective, which focuses on analyzing the impact of micro factors such as family structure, income level and values on the choice of elderly care models and consumption decisions.

2.2. From "Subsistence" to "Development": Paradigm shift of elderly care consumption

An increasingly clear consensus is that Chinese residents' elderly care needs are undergoing a profound paradigm shift. Ji (2020) ^[5] pointed out that the traditional elderly care consumption paradigm is centered on "subsistence security," and consumption content is highly concentrated on basic daily care and disease treatment. However, with economic and social development and the rise of the "new generation" of elderly groups, a development-oriented elderly care consumption paradigm emphasizing "spiritual satisfaction, social participation, and quality of life" is taking shape. Research by Li et al. (2024) ^[4] indicates that the consumption willingness of the elderly group in culture, entertainment, lifelong learning, and tourism is growing rapidly, and the consumption structure

is changing from single to diversified. This change in consumption paradigm poses a severe challenge to the existing elderly care service supply system that mainly meets basic subsistence needs. The mismatch between supply and demand has become a bottleneck restricting the improvement of the overall effectiveness of the elderly care service system.

2.3. Analytical framework of this study

Based on the above literature review, this study constructs an integrated analytical framework. The framework holds that residents' elderly care consumption behavior is the result of the interaction of their own life cycle characteristics (such as age and health status), family resources (such as living status and support capacity), external policy environment (policy awareness and evaluation), and market information environment. These factors interact to jointly shape residents' resource allocation logic between “subsistence-oriented consumption” and “development-oriented consumption”. This study will focus on examining the structural characteristics of elderly care consumption (consumption content, budget, payment willingness) and their correlation with key influencing factors (such as age, living status, policy awareness). The analytical framework is shown in **Figure 1**.

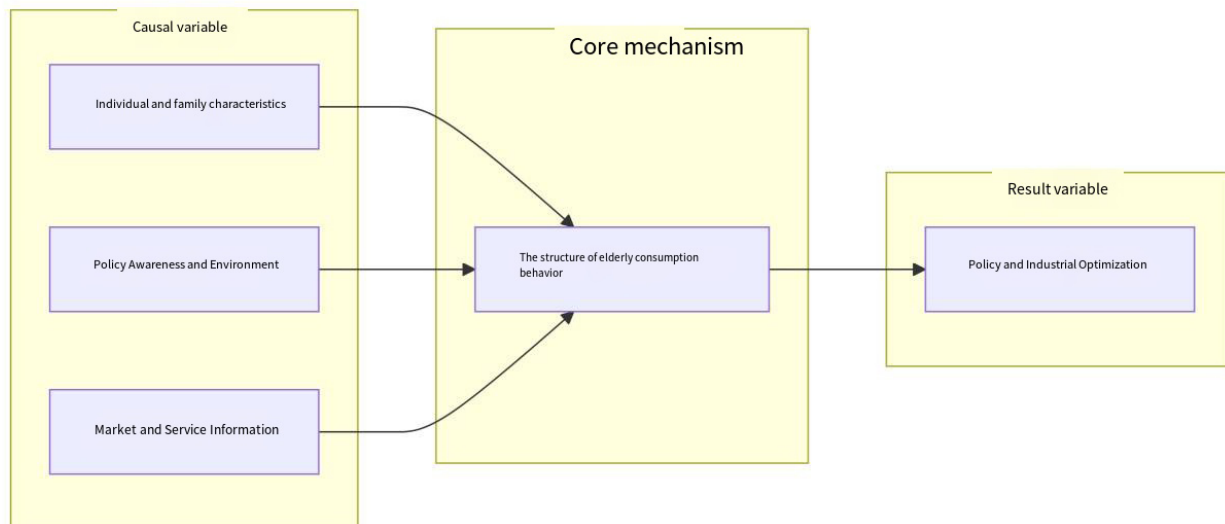


Figure 1. Mechanism and path diagram of the impact of elderly care consumption behavior.

3. Research design

3.1 Data source and sample characteristics

This study adopts the online questionnaire survey method, using snowball sampling through social media, online communities and other channels. A total of 727 questionnaires were collected. After strict screening (excluding invalid questionnaires with excessively short filling time and regular answers), 708 valid questionnaires were obtained, with an effective rate of 97.38%. As shown in **Figure 2**, from the perspective of sample structure, the middle-aged and elderly groups aged 45 and above account for 77.99%, the 35–44 age group accounts for 12.93%, the 25–34 age group accounts for 8.94%, and the 18–24 age group accounts for 0.14%. The sample covers residents living alone (15.82%), living with family (50.21%) and other living statuses (33.98%), with good representativeness.

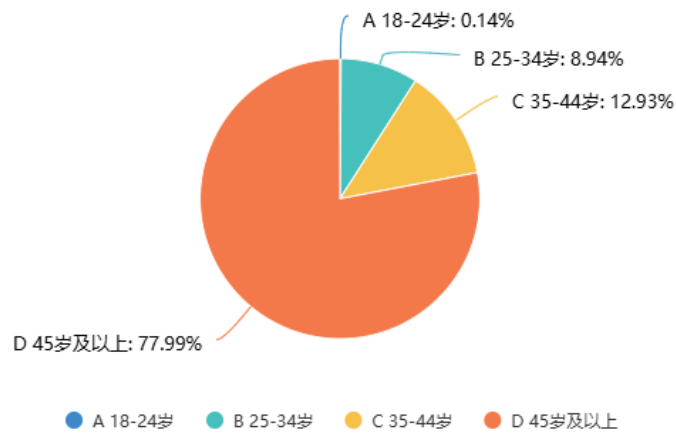


Figure 2. Pie chart of the proportion of people in different age groups.

3.2. Variable measurement and reliability and validity

The questionnaire includes three parts:

- (1) Demographic variables (age, living status, etc.);
- (2) Elderly care cognition and policy understanding;
- (3) Elderly care consumption behavior (consumption content, budget, payment willingness, influencing factors, etc.).

Cronbach's α coefficient was used for the reliability test, and the overall coefficient was 0.751, indicating good reliability of the questionnaire. KMO sample measure was used for the validity test, with a value of 0.844, indicating good construct validity of the questionnaire.

3.3. Analytical methods

This study mainly uses SPSS software for data analysis. First, descriptive statistics are used to present the sample overview and core characteristics of elderly care consumption; then, cross-tabulation analysis and chi-square test are used to explore the differences in elderly care consumption behavior among groups with different ages, living statuses and policy awareness, so as to reveal their structural characteristics.

4. Research findings and analysis

4.1. “Reality-expectation” dual structure of elderly care consumption

The survey clearly reveals the duality of residents' cognition of elderly care consumption. Regarding the “main content of current elderly care consumption” ^[6], medical expenses (36.86%) and living expenses (29.02%) dominate, accounting for 65.88% in total, showing a typical “subsistence-oriented” structure. However, in the expectation of “possible future elderly care consumption expenses” (multiple-choice question), the pattern reverses: culture and entertainment (67.13%), living expenses (65.34%), and tourism and leisure (50.76%) become the mainstream, while medical expenses (32.05%) retreat to a secondary position (**Figure 3**). This huge tension between “reality” and “expectation” indicates that residents' elderly care consumption concepts are undergoing fundamental changes, providing a strong demand driving force for the elderly care industry to upgrade from “security-oriented” to “quality-oriented.”

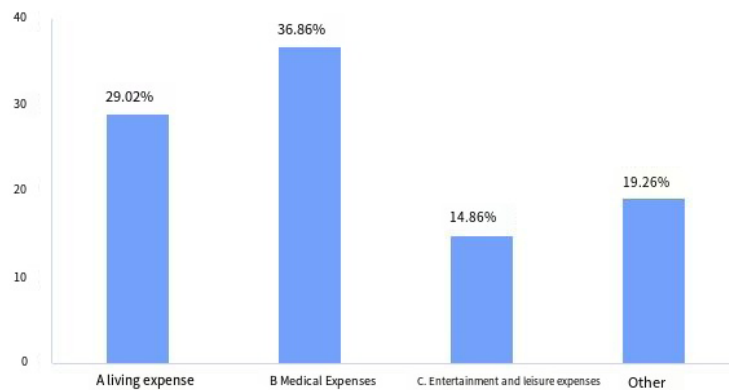


Figure 3. Bar chart of the proportion of the main contents of current residents' elderly care consumption.

4.2. Service quality: Multi-group pain point and structural imbalance

The quality of elderly care services is the most concerning pain point of residents, with 31.91% of respondents listing it as the “most needed improvement” aspect. Cross-analysis further reveals its structural characteristics: elderly residents living alone have both the highest demand for service quality improvement and social support, reflecting their deep dependence on professional external services. In contrast, residents living with their families have more comprehensive needs, with high expectations for service quality, medical security, living conditions, and other aspects. This indicates that the current supply of elderly care services has common shortcomings in professionalism, personalization and accessibility, and cannot meet the differentiated and refined needs of residents in different living conditions ^[7].

4.3. Policy awareness: A key lever to activate payment willingness

A policy-relevant finding is that there is a significant correlation between residents' policy awareness and their willingness to pay for high-quality services ($\chi^2 = 45.32, p < 0.001$). Among the groups that “very well understand” national elderly care policies, more than 95% stated that they are “very willing” or “willing” to pay higher fees for better services. In contrast, among the groups that “completely do not understand,” this proportion drops sharply to less than 20%. This strongly indicates that policy publicity is not only an information transmission, but also a “activation mechanism” for cultivating market confidence and releasing consumption potential. Understanding the security expectations brought by policies can significantly enhance residents' sense of security and payment willingness.

4.4. Information ecology: Dominance of “acquaintance trust” and lack of professional channels

In terms of information acquisition channels, the elderly care consumption market presents a complex picture of the coexistence of “tradition” and “modernity” (**Figure 4**). “Recommendations from friends or family” has become the main channel with an absolute advantage of 80.06%, reflecting the path dependence on “acquaintance trust” in high-involvement decisions. Professional institutions (61.07%) and the Internet (46.91%) have become important supplements, but have not been able to shake the dominant position of the former. This reflects the lack of a unified, authoritative, and transparent official public service platform for elderly care information. Residents face the dilemma of mixed information and high identification costs when making decisions, which to a certain extent, inhibits market efficiency.

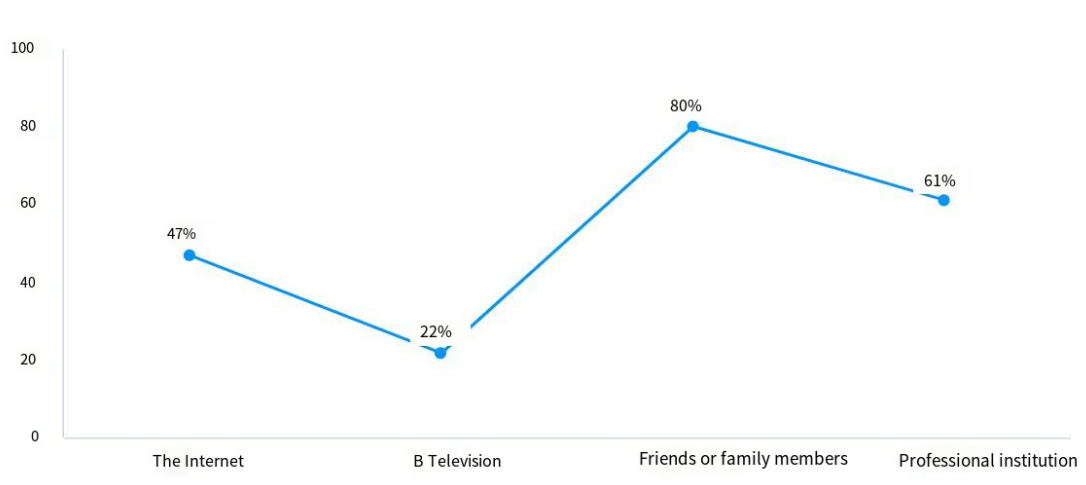


Figure 4. Line chart of the proportion of information acquisition channels for elderly care consumption.

5. Conclusions and policy implications

5.1. Conclusions

This study shows that Chinese residents' elderly care consumption behavior is in a transition period from the "subsistence security paradigm" to the "quality of life paradigm," and presents distinct structural characteristics: a dual "reality-expectation" structure in consumption cognition, service quality as a core pain point across different groups, policy communication effectiveness directly restricting the release of market payment willingness, and the information ecology remaining in the "acquaintance society" trust model. These characteristics collectively point to the systematic challenges faced by the elderly care service system in the supply side, policy transmission end and social support network.

5.2. Policy implications

Based on the above conclusions, this paper proposes a systematic "four-in-one" optimization path:

(1) From the supply side

Promote structural reform and industrial integration. Encourage market supply to shift from "singleness" to "gradation" and "refinement." On the one hand, the government should strive to ensure the quality of basic and inclusive elderly care services, and consolidate the bottom line of "subsistence-oriented" consumption. On the other hand, through policy guidance and market mechanisms, vigorously develop integrated formats such as "elderly care + culture," "elderly care + tourism," and "elderly care + technology" to meet residents' expectations for "development-oriented" consumption, forming a market pattern driven by both "security" and "quality."

(2) From the policy end

Implement precise communication and strengthen confidence and empowerment. Change the extensive policy publicity to precise communication based on the life cycle. For young people, use new media platforms to carry out enlightenment education on elderly care planning and financial tools; for middle-aged and elderly people, carry out face-to-face policy interpretation and application guidance through communities. The core goal is to enhance residents' sense of policy gain and clarity, thereby transforming policy dividends into tangible market confidence and consumption actions.

(3) From the individual end

Advocate full-cycle planning and guide rational decision-making. Advance elderly care education, and popularize the concept of full-life-cycle elderly care planning through the national education system and public publicity. Vigorously promote financial tools such as personal pension accounts and commercial endowment insurance to help residents, especially young groups, carry out intertemporal financial planning as early as possible, smooth consumption throughout the life cycle, and alleviate anxiety about future payment capacity.

(4) From the social end

Build a smart information platform and optimize the decision-making environment. Led by the government, integrate market resources to build a national or regional smart elderly care information platform integrating policy release, service institution inquiry, quality evaluation, and price comparison. This will break information barriers, reduce residents' search and identification costs, and guide consumption decisions from relying on "acquaintance experience" to relying on "authoritative information," thereby improving the operational efficiency and transparency of the entire market.

Funding

2025 College Student Innovation and Entrepreneurship Training Program of Changji University

Disclosure statement

The author declares no conflict of interest.

References

- [1] Mu G, Zhang Y, 2023, Development Trends and Strategic Responses to Population Aging in China. *Social Sciences in China*, 2023(1): 130–140.
- [2] Zheng B, 2022, Research Paths and Policy Prospects of China's Pension Reform. *Economic Research Journal*, 57(8): 4–20.
- [3] Wang L, Chen Y, 2023, Travel Elderly Care: Concept, Model and Development Path Analysis. *Journal of Aging Science Research*, 11(2): 58–70.
- [4] Li Z, Wang X, 2024, Research on the Stimulation Path of Cultural Consumption of the Elderly Group in the New Development Stage. *Journal of Shandong University (Philosophy and Social Sciences Edition)*, 2024(1): 112–123.
- [5] Ji P, Li F, 2020, Analysis of the Demand Willingness and Influencing Factors of Market-oriented Home-based Elderly Care Services for Rural Elderly People—Based on Empirical Data from Jiangsu Province. *Lanzhou Academic Journal*, November 11, 2020.
- [6] Yang J, Zou J, 2021, Population Aging, Elderly Consumption and Its Structural Heterogeneity—Analysis Based on Time-varying Consumption Utility. *Economic Perspectives*, 2021(11): 20.
- [7] Guo S, Ni C, Li M, et al., 2024, Integration of Medical and Elderly Care and Elderly Consumption—Theory and Mechanism. *Population & Economics*, 2024(2): 75–88.
- [8] Li L, 2020, The Impact of Population Structure on Household Asset Choice and Consumption Behavior—Empirical Analysis Based on Micro Data, thesis, Xi'an University of Posts and Telecommunications.

- [9] Chen X, 2022, Research on the Allocation of Elderly Care Financial Assets of Residents During Their Life Cycle in China, thesis, Nanjing Audit University.
- [10] Zhou Y, 2021, Household Population Age Structure and Savings Propensity—From the Perspective of Intergenerational Economic Support, thesis, Shandong University of Finance and Economics.
- [11] Jin X, 2024, Research on the Types and Heterogeneity of Elderly Care Service Needs of Rural Elderly People, thesis, Chongqing Three Gorges University.
- [12] Wang Z, Wang B, Ju Y, 2022, The Trend Impact of Developing the Third Pillar Personal Endowment Insurance and Elderly Care Finance on Commercial Banks Under the Background of Population Aging. *Heilongjiang Finance*, 2022(9): 18–21.
- [13] Li R, 2021, Research on the Impact of Population Aging on Residents' Consumption Structure in China, thesis, Huaqiao University.
- [14] Ma Q, 2022, Research on the Consumption Behavior of the Elderly Under the Background of Population Aging—Knowledge Map Analysis Based on CiteSpace. *Fortune Times*, 2022(1): 145–147.
- [15] Wang K, 2024, The Impact of Population Aging on Residents' Consumption and Countermeasures. *Fortune Today*, 2024(17): 38–40.

Publisher's note

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

Restructuring the Curriculum for Vocational Undergraduate Finance and Economics Programs under the “Golden Faculty + Golden Teaching Materials” Dual-Element Collaboration Model

Weilong Liu*

Inner Mongolia Technical College of Mechanics & Electrics, Hohhot 010010, Inner Mongolia, China

**Author to whom correspondence should be addressed.*

Copyright: © 2025 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: Under the dual background of the typological development of vocational education and its deep integration with the digital economy, vocational undergraduate programs in finance and economics face an urgent need to cultivate high-level technical and skilled talents. The curriculum system, serving as the core vehicle for talent development, sees the quality of its restructuring directly determining educational outcomes. From the perspective of the synergistic collaboration between “Golden Standard” instructors and teaching materials, this paper analyzes existing problems within the curriculum system of vocational undergraduate finance and economics programs. It clarifies the core logic and value dimensions of this dual-element synergy, constructs a restructuring framework oriented by competency, driven by the dual elements, and characterized by dynamic adaptation. Furthermore, the paper proposes implementation pathways and safeguard mechanisms, aiming to provide practical guidance for enhancing the intrinsic quality of vocational undergraduate finance and economics programs.

Keywords: Vocational undergraduate education; Finance and economics programs; Golden standard instructors; Golden standard teaching materials; Dual-element synergy; Curriculum system restructuring

Online publication: November 14, 2025

1. Introduction

1.1. Research background

The National Implementation Plan for Vocational Education Reform explicitly states that vocational education and general education are two distinct types of education, possessing equal importance. As the highest level within the vocational education system, vocational undergraduate education focuses on cultivating technical and skilled talents with comprehensive professional abilities, innovative capabilities, and developmental potential. Finance and economics programs, being a professional cluster most closely linked to economic and social

development, face a triple challenge under the trends of business-finance integration and digital-intelligent empowerment driven by the digital economy: rapid iteration of job demands, updating of technical standards, and upgrading of competency requirements. Currently, “Golden Standard Instructors” and “Golden Standard Teaching Materials” have become the core levers for enhancing the intrinsic quality of vocational education. Within the “Five Golden” construction concept proposed by Guangxi Industrial Vocational and Technical College, “Golden Standard Instructors” serve as the guarantee, and “Golden Standard Teaching Materials” form the foundation; together, they constitute the core elements of curriculum development. However, in practice, the curriculum system for vocational undergraduate finance and economics programs still suffers from a “duality disconnect”: the practical expertise of excellent instructors often fails to be effectively translated into teaching materials, while the pedagogical value of high-quality teaching materials lacks precise implementation by proficient faculty. This results in a misalignment between the curriculum system and industry needs, creating a gap between the quality of talent cultivation and the competency requirements of job positions. Therefore, exploring the path for restructuring the curriculum system based on the “Golden Standard Instructors + Golden Standard Teaching Materials” dual-element synergy has become a critical proposition for the high-quality development of vocational undergraduate finance and economics programs ^[1–3].

1.2. Significance of the study

1.2.1. Theoretical implications

This research transcends the conventional mindset of curriculum development driven by a single element. It constructs a synergistic theoretical framework integrating “Golden Standard Instructors,” “Golden Standard Teaching Materials,” and the “Curriculum System,” thereby enriching the theoretical foundation of vocational undergraduate curriculum development and providing a new analytical perspective for enhancing program quality within the context of distinct educational types ^[4].

1.2.2. Practical implications

In response to the digital and intelligent transformation demands of finance and economics majors, an operational curriculum system reconstruction plan is proposed to address the collaborative challenges of “what to teach” and “how to teach,” assisting vocational undergraduate colleges in cultivating high-level talents that meet the job requirements of digital finance and economics, and enhancing their ability to serve regional economic development ^[5].

2. Existing problems in the vocational undergraduate finance and economics curriculum system

2.1. The course structure is out of alignment with the job competency requirements

The traditional finance and economics curriculum system still follows the “discipline-oriented” setting logic, with the three-stage structure of public basic courses, professional basic courses, and professional courses solidified. It lacks a systematic response to the ability requirements of new job groups such as intelligent finance and big data auditing ^[6]. A survey conducted by Jiaxing Polytechnic shows that under the background of the digital economy, the financial management job group has formed a capability chain of “business scenarios + data foundation → integration of business and finance + data collection → risk control + data analysis → business practice + data application”, but the current curriculum system has failed to form a matching ability advancement

path, resulting in a disconnection between students' practical abilities and job requirements^[7].

2.2. The collaborative mechanism between “golden teachers” and “golden textbooks” is lacking

On the one hand, there are shortcomings in the construction of the “dual-qualified” teacher team. Some teachers lack practical experience in enterprises and have insufficient digital and intelligent teaching capabilities, making it difficult for them to transform new technologies and new processes in the industry into teaching content^[8]. On the other hand, the construction of teaching materials lags behind the development of the industry. The content of traditional teaching materials is outdated, lacks real project carriers, and has not been timely integrated into the standards of the “1+X” certificates and the requirements of skills competitions. A more prominent issue is the insufficient coordination between the two: the participation of enterprise experts in the compilation of teaching materials is merely a formality, and teachers' ability to develop teaching materials is lacking, resulting in a vicious circle where “strong teaching staff but weak practical application, and teaching materials have content but are difficult to implement”^[9].

2.3. The course content is disconnected from the iteration of technological changes

The in-depth application of digital technology in the financial and economic field has given rise to new technological application scenarios such as financial robots, big data analysis, and blockchain auditing. However, most courses still mainly focus on traditional accounting and financial management knowledge, with a lack of digital intelligence course modules. The reform practice of Zhejiang Industry Polytechnic College shows that only 30% of the vocational undergraduate finance and economics majors have been offered courses related to big data finance and economics, and the course content is fragmented, failing to form a systematic digital intelligence ability cultivation system, which leads to the digital literacy of graduates being difficult to meet the demands of enterprises.

2.4. The evaluation system does not conform to the dual collaborative goals

The current course evaluation mostly adopts a single model of “theoretical examination + simple practical training,” which neither reflects the process-oriented guiding value of “golden teachers” nor the practice-oriented characteristics of “golden textbooks”^[10]. The evaluation indicators focus on knowledge memorization rather than ability achievement, lacking a comprehensive assessment of students' practical job operation ability, data analysis ability and professional quality, making it difficult to play the guiding role of evaluation in dual-element collaborative education.

3. The core logic of the dual-element collaboration of “golden teachers + golden textbooks”

3.1. The definition of the connotation of dual synergy

3.1.1. The core traits of “golden master”

Unlike academic teachers in regular undergraduate colleges, “golden teachers” in finance and economics at vocational undergraduate institutions should possess the “Three Doubles and Four Abilities” traits: “Three Doubles” refer to dual identities (teacher + enterprise consultant), dual abilities (teaching ability + practical ability), and dual qualities (professional quality + digital quality). The “Four Abilities” refer to the ability to build

resources, innovate in the classroom, participate in competitions and obtain certificates, carry out educational reform and research, and precisely design teaching content in line with industrial demands and implement the teaching process with digital and intelligent tools.

3.1.2. The core features of the “golden textbook”

As the “script” for talent cultivation, the “golden textbooks” of finance and economics should highlight practicality, digital intelligence and dynamics. Specifically, it is manifested as: integrating new industry standards, new technologies and new methods in the content; It adopts new forms such as loose-leaf style and work manual style, and is equipped with digital resources. In terms of development, a school-enterprise co-construction system is implemented, with the participation of enterprise experts and school teachers to ensure a close connection with the actual positions ^[11].

3.1.3. The essence of dual synergy

The dual-element collaboration of “golden teachers + golden textbooks” is not a simple superposition. Instead, it is based on the curriculum system as a link, forming a dynamic cycle mechanism where “teachers’ capabilities are transformed into textbook content, textbook content supports teachers’ teaching, and both jointly serve the cultivation of capabilities.” The practical advantages of Jinshi provide vivid materials for Jinshi textbooks, and the systematic architecture of Jinshi textbooks offers a standardized framework for Jinshi’s teaching. The two work together to achieve precise alignment between course content and industrial demands, teaching processes and work processes, as well as ability cultivation and job requirements ^[12].

3.2. The value dimension of dual synergy

3.2.1. Dimension of ability cultivation

Through Jin Shi’s precise deconstruction of job capabilities and Jin Textbook’s systematic presentation of ability modules, a three-in-one ability cultivation system of “knowledge - skills - qualities” is constructed to achieve advanced cultivation from specialized abilities to comprehensive abilities.

3.2.2. Dimension of industrial adaptation

The combination of Jinshi’s advantage of being rooted in the front line of the industry and the dynamic update feature of Jinshi textbooks enables the curriculum system to respond quickly to the technological changes and job iterations in the financial and economic industry, enhancing the adaptability of talent cultivation ^[13].

3.2.3. Dimension of teaching effectiveness

The teaching innovation ability of Jin Shi and the resource support function of Jin Textbook form a synergy, promoting the transformation of the teaching model from “knowledge imparting” to “ability cultivation,” and improving the quality of classroom teaching and the effectiveness of education.

4. The framework for reconstructing the curriculum system under the dual-element synergy

4.1. Reconstruction principle

Starting from the core competencies of the new job clusters in finance and economics, the disciplinary knowledge

system is broken, and a course structure centered on ability modules is constructed. Deeply integrate the practical experience of Teacher Jin with the content system of the Jin textbook, and run through the entire process of course objective setting, content selection, teaching implementation, and evaluation feedback. Establish a dynamic adjustment mechanism for courses based on industrial demands to ensure that course content is updated in a timely manner in line with technological development and job changes. Integrate job standards, competition requirements and certificate norms into the curriculum system to achieve an organic connection between teaching content and professional standards ^[14].

4.2. Reconstruct the framework

The design is based on the dual-element collaborative logic to construct a framework for the reconstruction of the curriculum system featuring “one layer, three domains and four modules.” The core layer is a dual-element collaborative hub, composed of the “Golden Teacher Teaching Innovation Team” and the “Golden Textbook Development Center” jointly established by the school and enterprises, responsible for the overall design, content update and quality monitoring of the curriculum system. The Jinshi team leads the research on job capabilities and the setting of course goals, while the Jinshi Textbook Development Center is responsible for converting the capability requirements into textbook content and course modules. The supporting domain consists of three major guarantee systems, including the industry-education integration platform, digital and intelligent teaching resources, and the quality evaluation mechanism. The industry-education integration platform provides a practical carrier for dual-element collaboration, digital and intelligent teaching resources offer technical support for course implementation, and the quality evaluation mechanism provides a feedback loop for the collaborative effect. The course modules are divided into four types of course clusters. The basic ability module covers courses such as basic knowledge of finance and economics, basic digital technology, and professional ethics. The Jinshi team has developed loose-leaf basic textbooks in line with industry basic standards to lay a solid foundation for students’ abilities. The core competence module sets up core courses around job clusters such as intelligent finance, big data auditing, and digital taxation. Project-based teaching materials are jointly developed by enterprise experts and financial advisors, integrating real work cases and application scenarios of digital intelligence tools. For instance, Zhejiang Industry Polytechnic College has designed six projects and four tasks in the “Enterprise Taxation Practice” course in line with the job requirements of intelligent finance and taxation, achieving the integration of positions, courses, competitions and certificates. The expansion ability module sets up cross-disciplinary elective courses and innovation and entrepreneurship courses. Jinshi University develops specialized teaching materials based on research topics and industrial hotspots to cultivate students’ innovative thinking and cross-border abilities. The practical ability module builds a practical course system of “on-campus simulation + off-campus practical combat.” Jinshi takes the lead in developing virtual simulation training materials, and enterprise mentors are responsible for guiding on-the-job internship projects, forming a progressive, practical teaching chain of abilities ^[15].

5. The implementation path of the curriculum system reconstruction under dual-element collaboration

5.1. Build a dual-element collaborative curriculum development mechanism

- (1) Form a cross-border integrated Golden Master team. Establish a “two-way flow between schools and enterprises” mechanism. On the one hand, select teachers to take up positions such as financial advisors

and data analysts in enterprises to enhance their practical abilities. On the other hand, leading talents from enterprises, financial directors, etc., are hired as part-time teachers to form a structured teaching innovation team. Jiaxing Polytechnic has gathered industry experts, enterprise mentors and vocational education peers to build a high-level dual-qualified team, providing support for curriculum reform.

- (2) Develop a golden textbook system jointly built by schools and enterprises. The “dual chief editor and dual proofreader” system is implemented, with school experts and enterprise experts jointly serving as the chief editors of the textbooks to ensure that the content is both academic and practical. Focus on developing three types of teaching materials: The first is new forms of teaching materials that connect with digital and intelligent technologies, integrating contents such as financial robots and big data analysis; The second is a work manual-style teaching material that aligns with job processes, with teaching modules designed according to work links. Third, the practical training materials should be in line with the requirements of the competition and certificates, integrating the key points of the skills competition and the assessment standards of the certificates.
- (3) Establish a dynamic and updated content adjustment mechanism. Relying on the industry-education integration community, industry research is conducted every quarter. The Jinshi team sorts out the changes in job capabilities, and the Jinshi Textbook Development Center updates the textbook content and course modules in real time. Qilu University of Technology has established a textbook construction fund and assessment mechanism to ensure the timely iteration of textbook content.

5.2. Implement a dual-driven teaching organization reform

Promote the “Four-Classroom Synergy” teaching model, integrating the teaching innovation capabilities of Golden Teachers with the resource advantages of Golden textbooks, and build a four-in-one model of “digital intelligence classroom + practical classroom + research classroom + ideological and political classroom.” The digital and intelligent classroom conducts blended online and offline teaching by relying on the digital resources that come with the Golden Textbook. The practical classroom is led by Teacher Jin, who guides students to complete real enterprise projects. The research classroom transforms Professor Jin’s scientific research achievements into teaching content. The ideological and political education class integrates the requirements of accounting professional ethics, such as the “Three Firsts and Three Adherences.” Build a digital and intelligent teaching implementation platform, establish a virtual simulation training center and an online teaching platform, integrate the micro-lessons, animations developed by Jinshi with the training resources that match Jinshi textbooks, and achieve the teaching transformation of “real projects, real positions, real environments, and real processes.” Zhejiang Industry Polytechnic College has significantly enhanced the practical teaching effectiveness of finance and economics majors by establishing a provincial virtual simulation training center. Establish a multi-dimensional and three-dimensional course evaluation system: The Jinshi team designs evaluation indicators, combines the ability goals of Jinshi textbooks, and implements an evaluation model that combines “process evaluation + result evaluation + value-added evaluation.” Process evaluation focuses on the dynamic feedback from finance teachers on the completion of students’ projects. The result evaluation adopts a combination of paperless examinations and practical operation assessments. Value-added evaluation focuses on the extent of students’ ability improvement and comprehensively reflects the effectiveness of dual-element collaborative education.

5.3. Improve the guarantee mechanism for dual-element collaboration

In terms of institutional guarantees, documents such as the “Management Measures for the Construction of

the Golden Teacher Team” and the “Detailed Rules for the Development and Selection of Golden Textbooks” have been issued, clearly defining the division of responsibilities and incentive mechanisms for the dual-element collaboration. Incorporate textbook development and enterprise practice into the teacher assessment and evaluation system to stimulate the intrinsic motivation of Golden Teachers to participate in course construction. In terms of resource guarantee, a special fund for dual-element collaborative construction has been established, which is used for the training of financial experts, the development of teaching materials, platform construction and other work. Build a community of industry-education integration and enterprise training bases to provide real scene support for the practice and textbook development of Jinshi. In terms of quality assurance, a “school-enterprise co-management” quality monitoring committee has been established, with the participation of industry experts, representatives of gold teachers, and enterprise mentors. Regular evaluations of the adaptability of the curriculum system and the synergy effect of the dual elements are conducted to form a closed-loop management of “research - design - implementation - feedback - optimization.”

6. Conclusions and prospects

6.1. Conclusion

The dual synergy of “golden teachers + golden textbooks” provides an effective path for the reconstruction of the finance and economics curriculum system in vocational undergraduate programs. This model breaks down the barriers of fragmented elements and builds a curriculum system that is “ability-oriented, dual-driven, and dynamically adapted,” achieving a deep integration of curriculum objectives with job requirements, teaching content with industry standards, and teaching processes with practical links. Its core value lies in transforming the practical advantages of Jinshi and the content advantages of Jinshi textbooks into advantages in talent cultivation, which can effectively enhance the comprehensive vocational abilities and development potential of students majoring in finance and economics.

6.2. Future outlook

With the continuous development of the digital economy and the in-depth advancement of vocational education reform, the “Golden Teacher + Golden Textbook” dual-element collaborative model needs to evolve to a deeper level. In the future, the application of artificial intelligence technology in binary collaboration can be further explored to develop intelligent teaching materials and adaptive teaching systems. Deepen cross-disciplinary collaboration and build a curriculum system that integrates finance and economics with multiple disciplines such as information technology and management science. Expand the perspective of international cooperation, draw on advanced international experience to develop internationalized gold textbooks, and cultivate financial and economic technical and skilled talents with international competitiveness.

Disclosure statement

The author declares no conflict of interest.

References

- [1] Li N, Zheng Z, 2024, Research on the Employment Situation of Graduates from Finance Economics Universities in China – An Analysis Based on the Employment Quality Report of Graduates from Six Finance and Economics

- Universities from 2018 to 2022. *Future and Development*, 48(11): 36–41.
- [2] Duan H, Xu N, Li C, 2024, Research on the Reconstruction of Practical Education System for Finance and Economics Majors from the Perspective of New Liberal Arts. *Communication of Finance and Accounting*, 42(5): 87–92.
 - [3] Xu C, Qi P, Xu J, 2024, Research on the Path Quality Optimization of Ideological and Political Education in Colleges and Universities under the New Liberal Arts Perspective – Taking Finance and Economics Applied Undergraduate Universities as an Example. *Ningbo Economy (Sanjiang Forum)*, 2024(5): 39–41.
 - [4] He K, Kah K, 2024, Current Situation, Trends and Reflections on Teaching Research in Finance and Economics Universities. *Journal of Hubei Open Vocational College*, 37(8): 165–167.
 - [5] Chai G, Shen W, 2024, Research on the Effect of the Reform of New Finance and Economics Undergraduate Talent Training in the Context of New Liberal Arts – Taking the Experimental Class of Hebei University of Economics and Trade as an Example. *Journal of Hebei University of Economics and Trade (Comprehensive Edition)*, 24(1): 88–91.
 - [6] Yang W, 2024, Research on the Countermeasures to Improve the Quality of Graduation Practice in Applied Finance and Economics Undergraduate Institutions – Taking Hubei University of Economics as an Example. *Journal of Hubei University of Economics (Humanities and Social Sciences Edition)*, 21(3): 135–138.
 - [7] Mou Y, Zhang L, 2023, Exploration of the Integration of Specialty Innovation Teaching Reform of Finance and Economics Majors under the New Liberal Arts Perspective. *Modern Commerce and Industry*, 44(2): 126–128.
 - [8] Zhang M, Zhang Y, 2024, Exploration of the Construction of Ideological and Political Education in the Course of “Financial Management” in Applied Undergraduate Institutions under the Background of New Liberal Arts. *University (Ideological and Political Education)*, 24(2): 98–101.
 - [9] Zhang W, 2023, Challenges and Opportunities of Higher Finance and Economics Vocational Education. *Journal of Tianjin Vocational University*, 32(3): 3–7.
 - [10] Chen H, 2023, Exploration of a New Practical Teaching System for Law Majors in Local Undergraduate Universities of Finance and Economics – Taking Guangdong Peizheng College as an Example. *Journal of Qingyuan Polytechnic*, 16(3): 73–78.
 - [11] Wu C, Gao X, 2024, Preliminary Discussion on the Reform of Chinese Economic History Courses in the Background of New Finance Reform. *Journal of Hubei University of Economics (Humanities and Social Edition)*, 21(5): 136–139.
 - [12] Han J, Liu M, Zhang J, 2023, “Digital-Intelligent” Transformation of Talent Training for Finance and Economics Majors in Local Undergraduate Universities under the Background of New Liberal Arts. *Journal of Hebei Agricultural University (Social Sciences Edition)*, 25(2): 124–130.
 - [13] Tang X, 2023, Research on the Integration Model of Industry and Education in Finance and Economics Vocational Undergraduate Education. *Modern Vocational Education*, 2023(8): 89–92.
 - [14] Shangguan Z, Wang S, 2024, Exploration and Practice of Virtual Teaching and Research in the Digital Age. *Audit Observation*, 2024(5): 91–96.
 - [15] Li S, 2023, Review and Reflection on the Construction of Library Resources in Specialty Colleges and Universities in the New “Double First-Class” Construction – Taking the Construction of Characteristic Collection in Finance and Economics Undergraduate Institutions as an Example. *New Century Library*, 2023(2): 52–58.

Publisher's note

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

Expanding College English Textbook Content with the Help of AI Tools

Jingquan Huang*

Guangzhou College of Commerce, Guangzhou 511363, Guangdong, China

**Author to whom correspondence should be addressed.*

Copyright: © 2025 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: With the rapid development of artificial intelligence (AI) technology worldwide, its revolutionary impact on the field of education is becoming increasingly prominent. College English, as a public basic course in higher education, aims to develop students' language application ability, cross-cultural communication ability and self-study ability. This paper takes specific unit themes from actual college English textbooks as examples and elaborates in detail how artificial intelligence tools are used in the four core teaching modules of listening, speaking, reading and writing to expand the content of the textbooks. The article emphasizes that teachers should take responsibility for ensuring the authenticity and accuracy of AI-generated content, strive to provide practical AI-assisted teaching strategies for college English teachers, maximize the effectiveness of teaching materials, and ultimately enhance students' comprehensive English application ability.

Keywords: College English teaching; Artificial intelligence technology; Textbooks

Online publication: November 14, 2025

1. Introduction

With the rapid development of artificial intelligence (AI) technology worldwide, its revolutionary impact on the field of education is gradually emerging. From the generation of teaching resources to the innovation of teaching models, AI technology is constantly reshaping every aspect of teaching. College English, as a public basic course in higher education, shoulders the important mission of cultivating students' language application ability, cross-cultural communication ability and self-study ability. The richness, timeliness and interactivity of textbooks, which are the core carriers of curriculum implementation, are directly related to teaching quality and learning outcomes.

This article will closely combine the actual teaching materials used in college English classrooms, take specific unit themes as cases, and start from the four core teaching modules of listening, speaking, reading, and writing to elaborate in detail how to use artificial intelligence tools to expand the content of teaching materials. Each module is based on the existing themes of the textbook and designs practical AI application plans, analyzing

their specific roles in assisting teachers' teaching and promoting students' learning. At the same time, the article emphasizes the teacher's responsibility for controlling the authenticity and accuracy of the content during the application of artificial intelligence. It aims to provide practical AI-assisted teaching strategies for college English teachers to maximize the effectiveness of teaching materials and ultimately improve students' comprehensive English application ability.

2. How to use AI tools to expand college English listening content

Listening is an essential part of college English teaching and a key channel for students to input language. However, the listening materials in traditional college English textbooks often have problems such as limited quantity, single scenarios, and outdated content, which are difficult to meet the diverse listening practice needs of students and cannot fully cover the rich content related to the textbook topics. Artificial intelligence tools, with their efficient audio generation and question design capabilities, can quickly build personalized listening resource libraries around textbook themes, effectively expand listening teaching content, and enhance students' listening practice effectiveness and learning interest^[1].

Take the unit topic "A matter of taste" in a college English textbook as an example, which focuses on food and dietary culture. Textbooks usually include listening materials about food preferences, table manners, or specific food introductions, but the content is often brief and the countries and cultural scenarios covered are very limited. At this point, teachers can expand the listening content in a targeted manner around the topic with the help of artificial intelligence tools. In practice, teachers should first clarify the core objective of the listening material: first, to supplement the food cultures of different countries that are not covered in the textbook and enrich students' cross-cultural cognition; second is to design listening questions that match the knowledge points in the textbook to enhance students' ability to capture and understand key information. Under this premise, teachers can input detailed generation instructions to the AI tool, such as: "Generate a short English passage of about 400 words around the theme of 'special foods of different countries.' The content should cover the origin, ingredient characteristics and cultural significance of four foods: Japanese sushi, Mexican tacos, Thai tom yum goong soup and Italian pizza. The language difficulty should be at CET-4 level, and obscure words should be avoided; Then design five multiple-choice questions based on the content of the article, each with four options A, B, C, and D. The questions should cover the core information of the article, such as the origin of food, main ingredients, cultural symbols, etc., along with detailed explanations of the answers."

After the artificial intelligence tool generates the listening text and questions, the teacher needs to conduct a strict review of the content, which is a key step to ensure the validity and accuracy of the listening materials. After the review is passed, the teacher can use the text-to-speech function of the AI tool to select the type of speech (such as American English or British English) that fits the pronunciation habits of native English speakers and the speaking speed (it is recommended to initially set the normal speaking speed and then adjust it to slow or fast according to the student's level) to convert the text into an audio file.

This way of expanding the listening content with the help of AI tools has significant teaching advantages: on the one hand, the listening materials are closely related to the theme of the textbook, ensuring the coherence and relevance of the teaching content and avoiding the disconnection between the extended resources and the textbook; On the other hand, rich cultural scenarios and diverse training forms can effectively stimulate students' interest in learning and increase their enthusiasm for actively participating in listening practice. At the same time, the generated audio and text materials can be distributed to students as after-class review resources to facilitate

their self-practice, further extend the learning time and enhance the effect of listening practice ^[2,3].

3. How to use AI Tools to develop students' ability to speak English boldly

Oral expression ability is an important indicator of students' comprehensive English application level and one of the difficulties in college English teaching. In traditional college English classes, oral practice is mainly based on imitation of textbook dialogues and group discussions, with problems such as limited practice opportunities, single scenarios, and lagging feedback. Artificial intelligence tools can effectively circumvent these problems by providing interactive practice scenarios for students and helping them overcome the difficulty of not speaking English.

Based on the unit topic in the textbook, "Is university gradually becoming a thing of the past?" Are universities slowly becoming a thing of the past? For example, this topic, which focuses on trends and values in higher education, has a strong critical thinking quality and is suitable for oral debate activities. Textbooks usually provide relevant reading materials or dialogue examples to guide students to think about the role of the university, but lack sufficient oral practice scenarios for students to express their views in depth. At this point, teachers can use artificial intelligence tools to design oral debate activities around the topic to create opportunities for students to practice speaking ^[3].

The implementation process can be divided into three stages: The first stage is the preparation stage. Teachers assign tasks to students 1–2 weeks in advance, clearly stating the topic of the debate as "Is university outdated?" (In line with the textbook theme), and let students choose either the affirmative side (thinking that university is outdated) or the negative side (thinking that university still has significant value). At the same time, the teacher guides students to sort out the debate ideas in combination with the reading materials and knowledge points in the textbook ^[4-6].

The second stage is the debate practice stage. Within a limited time frame (such as 30 minutes), students engage in one-on-one oral debates with the AI. The AI tool can act as a "debating opponent," presenting counterarguments based on the student's point of view. For example, when the affirmative student suggests that "online courses can replace university classrooms," the AI can retort: "Online courses lack the interactive learning environment provided by universities and the opportunity to interact face-to-face with professors, which are crucial for deepening knowledge understanding and solving complex problems." Meanwhile, AI can capture students' expressions in real time, make preliminary assessments of language fluency, vocabulary accuracy, and logical coherence, and give appropriate hints during the debate. For example, when a student stumbles or uses inappropriate words, the AI can gently remind: "You can use the phrase 'play an irreplaceable role in' to more accurately express the importance of college." The debate process can be written down by the AI for later use. It should be emphasized that the core objective of the debate is not to win or lose, but to enable students to boldly express their opinions in English and refute each other through interaction with AI, and to exercise their oral organization skills and on-the-spot adaptability. This approach is more effective in stimulating students' critical thinking and desire to express themselves than traditional daily conversation practice.

The third stage is the summary and feedback stage. After the debate, the teacher organizes students to give oral presentations in class. Each student is required to briefly present the main points of the debate with the AI, the core counterarguments raised by the AI, and their gains and shortcomings during the debate. For example, one student might share: "In the debate, the AI pointed out that my argument that 'university is outdated' lacked data support. This made me realize that more concrete cases are needed when expressing opinions in English."

The teacher then provided comments in combination with the textbook knowledge points and the students' presentation content, focusing on analyzing the students' strengths in oral expression (such as clear logic, rich vocabulary) and areas for improvement (such as grammatical errors, pronunciation problems), and reemphasizing the core points related to the topic in the textbook to help students deeply integrate the debate content with the textbook knowledge. In addition, students can review their own expressions by comparing the written records of the debate process and further optimizing their language use.

Through this AI-assisted oral debate activity, students can not only think deeply and express themselves around the subject of the textbook, but also overcome the fear of speaking English in a stress-free "human-computer interaction" environment and gradually build confidence in speaking English. Meanwhile, the real-time feedback and personalized guidance provided by AI can help students identify and improve their expression problems in a timely manner, effectively enhance the accuracy and fluency of their oral expression, and make up for the lagging feedback and limited practice opportunities in traditional classroom oral practice^[7-9].

4. How to use AI Tools to expand textbook reading content

Reading is an important way for students to acquire language knowledge, develop reading comprehension skills and critical thinking. Although the reading articles in college English textbooks are carefully selected, due to space limitations, they often fail to fully expand on the topic and provide sufficient interactive discussion space, resulting in students' understanding of the articles remaining superficial and lacking in-depth thinking. Artificial intelligence tools can generate in-depth and personalized extended content and interactive questions based on the textbook reading text, guide students to conduct group discussions and in-depth analyses, effectively expand the breadth and depth of reading teaching, and help students understand the textbook topic more comprehensively^[4].

Take the theme of the reading article "Being a learner for life" in the textbook as an example. Teachers can use AI tools to generate open-ended discussion questions around this reading article in the textbook, guiding students to think deeply and interact in groups.

The specific steps are as follows: First, the teacher inputs the full text of the reading article "Lifelong Learning" in the textbook into the AI tool before class, and clearly states to the AI the requirements for generating the question: First, the question should be closely related to the content of the article and not deviate from the textbook theme; Second, the questions should be open-ended and thought-provoking, capable of stimulating students' desire to discuss, rather than simply factual questions; Third, the questions should cover different dimensions and expand students' thinking comprehensively. Based on these requirements, AI tools can generate a series of high-quality discussion questions, such as:

- (1) What does "lifelong learning" mean to you personally? How does it differ from learning only at school?
- (2) What challenges do you think people might face in their efforts to become lifelong learners? How do you overcome these challenges?
- (3) How do you think lifelong learning can help with our future career development or personal growth?
- (4) With a vast amount of information available online, how do we, as lifelong learners, choose what to learn? What criteria should be adopted?

After generating the questions, teachers need to screen and adjust them to ensure that the difficulty of the questions matches the students' English proficiency and cognitive ability, while avoiding repetition or disconnection from the textbook content.

In the classroom, teachers can divide students into groups of 4-5 people, and each group selects an open-

ended question for discussion. Before the discussion, the teacher guides students to read the reading passage in the textbook again carefully and to look for evidence from the passage to support their point of view. For example, when discussing “The difference between lifelong learning and school learning,” ask students to identify from the article the characteristics, such as “lifelong learning is autonomous and practical,” and supplement them with their own experiences. During the discussion, the teacher walks around the groups and gives guidance, encourages students to express their views boldly in English, corrects language errors promptly, and leads students to think deeply. For example, when a group is discussing “How to choose learning content,” the teacher may ask: “Can you give an example from the article to support your criteria for choosing learning content?” To ensure that the discussion always revolves around the subject of the textbook and avoids going off track.

After the discussion, each group selects a group leader to give an oral presentation summarizing the group’s discussion results. For example, one group might report: “We think the main difference between lifelong learning and school learning is that lifelong learning is autonomous. As the article states, lifelong learners can choose what they learn based on their own interests, while school learning is more structured learning arranged by teachers.” After the group leader reports, the teacher organizes the whole class to supplement and comment, integrate the viewpoints of each group, and at the same time return to the textbook article, emphasizing the core viewpoints related to the discussed question in the article to help students build a complete knowledge system.

This approach of generating discussion questions and expanding reading content with the help of AI tools has multiple advantages: on the one hand, the questions are closely integrated with the textbook reading article, ensuring the relevance of the expanded content to the textbook and helping students deepen their understanding of the main idea of the article; On the other hand, the form of group discussions and oral presentations can stimulate students’ awareness of active thinking and cooperative learning, and develop their critical thinking and English expression skills ^[10,11].

5. How to use AI tools to assist students in writing practice

Writing is one of the most comprehensive and challenging modules in college English teaching, and it is also an important manifestation of students’ language output. In traditional writing teaching, after students complete the writing tasks assigned in the textbook, they usually only receive batch feedback from the teacher, which has problems such as long feedback cycles, insufficient targeting, and difficulty in covering individual problems of each student (such as grammatical errors, single sentence patterns, logical confusion, etc.). Artificial intelligence tools, with their precise text analysis and real-time feedback capabilities, can provide personalized writing guidance for students, effectively helping them improve writing problems and expand writing ideas, and become an important supplement to textbook writing exercises ^[12,13].

Take the unit theme “A journey to the unknown” in the textbook as an example. This theme unfolds around “The unknown journey”. Textbooks often assign related short essay writing tasks, such as “Talk about your views on travel and explain the meaning of travel.” In the practice of writing instruction, teachers can use artificial intelligence tools to assist students in completing writing exercises in three stages, effectively expanding the writing tasks in the textbook. After students complete the essay as required, they can upload the text to the AI tool to obtain time-limited writing feedback. The AI tool can provide students with precise guidance in four aspects: grammar, sentence patterns, vocabulary, and logic. After students revise their essays based on the feedback from AI, they submit both the first draft and the revised version to the teacher, who then gives the final comments ^[14].

Using AI tools to assist writing practice can effectively make up for the shortcomings of traditional writing teaching: on the one hand, the real-time feedback and personalized guidance provided by AI enable students to promptly identify and correct their writing problems, especially basic errors in grammar and sentence patterns, and help students improve language accuracy through repeated revisions; On the other hand, the thought suggestions and vocabulary expansion provided by AI can help students expand their writing thinking, flexibly apply the knowledge points in the textbook to writing, and avoid writing content that is empty or disconnected from the textbook. At the same time, AI feedback reduces the workload of teachers in grading homework, allowing teachers to have more time to focus on students' advanced writing skills (such as logical thinking and viewpoint expression), achieving a collaborative teaching model of "AI-assisted basic error correction + teacher-guided in-depth improvement", significantly enhancing the effectiveness of writing teaching^[15].

6. Conclusion

In the context of the deep integration of information and intelligence, artificial intelligence tools have become a key driving force for the reform of college English teaching. It centers on the themes of the teaching materials and, through its application in the four core modules of listening, speaking, reading, and writing, effectively expands the content of the teaching materials, optimizes the teaching process, and addresses the limitations of traditional teaching materials. Although the future development of artificial intelligence may bring immersive learning scenarios or personalized learning plans, textbooks remain at the core of college English teaching, with artificial intelligence serving only as an auxiliary tool. Teachers should focus on student development, organically integrate AI with teaching materials and teaching objectives, and explore efficient teaching models to improve students' English proficiency and cultivate their lifelong learning ability and cross-cultural communication skills.

Disclosure statement

The author declares no conflict of interest.

References

- [1] Sun Y, Richards J, 2021, *Over to You: An Integrated Course 1*. Foreign Language Teaching and Research Press, Beijing.
- [2] Brown H, 2020, *Principles of Language Learning and Teaching* (7th ed.). Pearson Education, White Plains, New York.
- [3] Warschauer M, Grimes D, 2022, Technology and Second Language Learning. *Annual Review of Applied Linguistics*, 42: 123–145.
- [4] Godwin-Jones R, 2021, Emerging Technologies in Language Learning. *Language Learning & Technology*, 25(1): 456–478.
- [5] Ellis R, 2019, *Understanding Second Language Acquisition* (3rd ed.). Oxford University Press, Oxford.
- [6] Hegelheimer V, Fisher D, 2023, AI-Enhanced Language Teaching Materials: Design Principles and Practical Applications. *Computer Assisted Language Learning*, 36(3): 456–478.
- [7] Chen J, 2013, *Research on the Construct of Foreign Language Teaching Tests*, thesis, Shanghai International Studies University.

- [8] Ge J, 2021, Research and Practice of College English Based on Artificial Intelligence. *Campus English*, 2021(32): 7–8.
- [9] Lai Y, 2023, Research and Practice of Innovation and Entrepreneurship Theory. *Innovation and Entrepreneurship Theory*, 2023(21): 175–180.
- [10] Dong L, 2023, Exploration of Information Transformation in Modern College English Teaching—A Review of Research on College English Teaching and Teachers’ Information Literacy. *Chinese Science and Technology Papers*, 18(8): 940.
- [11] Jia H, 2022, Research on Multimodal Information-Based Teaching of College English in the Era of Artificial Intelligence. *Journal of Inner Mongolia University of Finance and Economics*, 20(1): 4.
- [13] Qi Y, Yuan Z, 2025, A Review of Blended Teaching of College English at Home and Abroad (2015–2024). *Journal of Hubei University of Arts and Science*, 46(3): 67–72.
- [14] Hou W, Li N, Wang L, et al., 2024, Knowledge Graph-Based Artificial Intelligence-Enabled Resource Integration Strategies for College English Immersion Teaching. *Modern English*, 2024(13): 50–52.
- [15] Liang H, Yu P, 2025, A Preliminary Study on the Construction and Application of Textbook Resources for Smart College Art English Courses. *Modern English*, 2025(6): 54–56.

Publisher’s note

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

Research on the Pathways of Integrating the Cultivation of Intercultural Communication Competence into College English Teaching

Yuchen Ye*

Macau University of Science and Technology, Fuzhou 350000, Fujian, China

**Author to whom correspondence should be addressed.*

Copyright: © 2025 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: With the rapid development of globalization, students are expected not only to master language proficiency but also to possess intercultural communication competence, enabling them to adapt to frequent exchanges across diverse cultural contexts. However, current college English teaching often overemphasizes linguistic knowledge and test-taking skills while neglecting the cultivation of intercultural communication competence and awareness. As a result, students lack authentic intercultural communication ability. Integrating the development of intercultural communication competence effectively into English classroom teaching has therefore become a key issue in higher education.

Keywords: Intercultural communication competence; College English teaching; Classroom practice

Online publication: November 14, 2025

1. Introduction

Intercultural communication competence refers to the ability to understand and express oneself effectively across different cultural contexts, while respecting others' cultural habits and values. Cultivating such competence in college English teaching not only enhances students' language proficiency but also deepens their cross-cultural understanding. At present, college English education remains focused primarily on linguistic knowledge and test-taking skills, relying on monotonous and rigid teaching methods that fail to provide students with authentic intercultural communicative environments.

2. Theoretical foundations for cultivating intercultural communication competence in college English teaching

2.1. Intercultural communication competence theory

This theory holds that language learning involves more than acquiring pronunciation, vocabulary, and grammar—it requires the ability to communicate effectively in varied cultural contexts. It emphasizes that learners should

understand and respect the interactive relationship between different cultural values, behavioral norms, and thought patterns ^[1]. Intercultural communication competence consists of three dimensions: cognitive, affective, and behavioral. The cognitive dimension involves knowledge of different cultures—language conventions, social norms, etiquette, and historical backgrounds ^[2]. The affective dimension concerns attitudes, emotions, and values, calling for respect toward cultural diversity, open-mindedness, and empathy ^[3]. The behavioral dimension refers to the ability to apply linguistic and cultural skills flexibly in real communication to resolve conflicts and achieve mutual understanding ^[4].

2.2. Constructivist learning theory

Constructivism posits that learning is not a passive reception of knowledge but an active process in which learners construct new understanding through the interaction between prior experience and new information. Knowledge construction depends on learners' experiences, backgrounds, and cognitive structures ^[5], developing through exploration, reflection, and interaction. In college English teaching, constructivism calls on teachers to respect students' subjectivity, design authentic scenarios, and motivate learners to explore knowledge independently, analyze cultural phenomena, and form their own insights. Social interaction plays a key role, as collaboration and communication foster both linguistic competence and intercultural understanding ^[6].

2.3. Communicative context theory

Communicative context theory emphasizes that language learning and use should occur within real or simulated communication contexts ^[7]. Language development must be anchored in authentic communicative situations where learners learn to use language functions appropriately and follow cultural norms to achieve effective interaction ^[8]. Teachers are encouraged to create authentic settings, facilitate role-plays, and analyze real examples to enable students to experience cultural differences in context. The theory also advocates for flexible communication strategies, urging learners to adapt their communicative behaviors according to time, situation, and context to enhance intercultural competence ^[9].

3. Current situation and problems in cultivating intercultural communication competence in college English teaching

3.1. Limited course content

Most college English courses still rely heavily on teacher-centered lecturing, with little student participation or teacher–student interaction. Cultural topics are often presented in isolated fragments—covering background, etiquette, or festivals—without systematic design or phased planning, making it difficult for students to build coherent intercultural cognitive frameworks ^[10]. Outdated content fails to reflect the evolving realities of globalization, leading to a lack of exposure to authentic intercultural contexts. Such limited content restricts students' cross-cultural understanding and impedes the development of effective communication strategies ^[11].

3.2. Traditional teaching methods

Teaching methods remain dominated by lecturing, leaving students passive recipients of information. This approach prioritizes linguistic knowledge over communicative practice, preventing effective cultivation of intercultural competence. Opportunities for autonomous and collaborative learning are scarce, and practical simulations are rare. Teachers tend to focus on language testing rather than cross-cultural discussions or

comparisons, which limits students' awareness and adaptability in intercultural communication. As a result, traditional methods dampen learning motivation and hinder comprehensive intercultural skill development^[12].

3.3. Restricted evaluation systems

Current evaluation systems in college English teaching mainly assess linguistic knowledge—vocabulary, grammar, reading, and writing—while overlooking cultural and communicative dimensions^[13]. Such exams fail to measure students' intercultural cognition, attitudes, or communicative behaviors. Since intercultural competence encompasses language use, cultural understanding, sensitivity, emotional attitudes, and behavioral adaptability, traditional quantitative tests cannot capture these aspects. The absence of formative and process-based evaluation prevents teachers from tracking student progress and refining instruction. Furthermore, students' creativity and participation are not adequately recognized, impeding the development of their intercultural practical abilities.

4. Integrating intercultural communication competence into college English teaching

4.1. Course design and content optimization

Integrating intercultural communication competence requires optimizing curriculum design. Course objectives should explicitly include intercultural competence, ensuring synchronous development of language skills and cultural understanding^[14]. Content should be structured systematically and modularly to encompass language training, cultural cognition, communication strategies, and global perspectives. A progressive framework—from basic cultural knowledge to complex communication scenarios—should guide learning.

For example, business English courses may include a module on “International Business Etiquette and Negotiation Strategies”, helping students grasp differences in communication styles across cultures. Activities such as reading, group discussions, and comparative studies on festivals, customs, and cultural events should reinforce understanding. Through such a structured design, students not only improve their language skills but also learn to apply intercultural knowledge effectively in real communication.

4.2. Innovative teaching methods

To develop intercultural competence, teaching methods must shift toward student-centered and participatory approaches such as task-based learning, cooperative inquiry, project-based learning, and situational simulations. These methods immerse students in authentic communicative contexts, enhancing their ability to interpret cultural differences and apply adaptive strategies. Teachers act as facilitators, guiding exploration through problem-solving, case studies, and scenario design.

For instance, when studying “International News Reporting,” students can role-play as journalists and interviewees from different countries to practice communication strategies and cultural adaptation. Group projects and case analyses can encourage students to research global consumer habits or social etiquette, fostering both linguistic and intercultural growth.

4.3. Reforming the evaluation system

An improved evaluation system should encompass cognitive, affective, and behavioral dimensions of intercultural competence. Assessment should be multidimensional, formative, and process-oriented, covering

language proficiency, cultural awareness, communication strategy, attitude, and behavioral expression. Evaluation methods may include classroom participation, project assignments, role-play performance, and peer/self-assessment, focusing on both outcomes and learning processes.

For example, in a course like “International Marketing,” teachers can evaluate students’ simulated negotiation performances from linguistic, strategic, and attitudinal perspectives. Continuous feedback enables students to identify weaknesses and make timely improvements. A diversified evaluation framework not only reflects students’ comprehensive intercultural abilities but also fosters engagement and sustained motivation.

4.4. Application of information technology

Information technology plays a vital role in cultivating intercultural competence. Digital platforms, online resources, and virtual learning environments can provide rich and interactive cross-cultural experiences. Teachers can integrate global cultural materials, facilitating case-based learning from multiple perspectives^[15]. Online collaborations and intercultural exchanges—via virtual teams, discussion forums, and video conferences—allow students to practice authentic communication.

For instance, in an “International Media and Culture” course, students can conduct virtual exchanges with peers abroad, discussing global issues through online meetings and multimedia presentations. Such digital environments not only enhance participation and adaptability but also provide valuable learning analytics to support individualized instruction. Technology-driven teaching thus fosters more intelligent, interactive, and globally oriented English classrooms.

5. Conclusion

In the era of globalization, intercultural communication competence has become an essential goal of college English education. Future English teaching should integrate intercultural education more effectively by redesigning curricula, innovating teaching methods, reforming evaluation systems, and utilizing digital and AI technologies. Through continuous reflection and practice, students will not only refine their linguistic proficiency but also develop acute intercultural awareness and strong communicative competence, laying a solid foundation for learning, working, and interacting in both domestic and international contexts.

Disclosure statement

The author declares no conflict of interest.

References

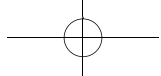
- [1] Cao Z, Ruan S, 2025, Exploring the Path to Cultivating Students’ Intercultural Communication Competence in College English Teaching. *Academic Weekly*, 2025(04): 37–40.
- [2] Lai J, 2024, A Study on Strategies for Integrating the Cultivation of Intercultural Communication Competence into College English Teaching. *English Square*, 2024(07): 71–74.
- [3] Li Y, 2023, Integrating the Cultivation of Intercultural Communication Competence into the Teaching Practice of College English Courses. *Popular Literature and Art*, 2023(16): 83–85.
- [4] Zhang D, 2023, How to Integrate the Cultivation of Intercultural Communication Competence into the Teaching

Practice of College English Courses. *Campus English*, 2023(25): 136–138.

- [5] Chen X, Wang J, 2023, Reflections on the Path to Cultivating Intercultural Communication Competence in College English Teaching—A Review of “Research on Theory and Practice of College English Education.” *Educational Development Research*, 2023(16): 83–85.
- [6] Li Y, 2023, Integrating the Cultivation of Intercultural Communication Competence into the Teaching Practice of College English Courses. *Popular Literature and Art*, 2023(16): 83–85.
- [7] Jia Q, Li Y, 2023, The Path of Cultivating Students’ Intercultural Communication Competence in College English Writing Teaching. *Campus English*, 2023(02): 34–36.
- [8] Ma D, Yan W, 2023, Research on the Cultivation of Intercultural Communication Competence in College English Teaching. *Theoretical Observation*, 2023(2): 3.
- [9] Bao X, 2023, Cultivation and Research of Intercultural Communication Competence in College English Teaching. *Journal of Kaifeng Education Institute*, 2023(2): 2.
- [10] Li W, 2022, Exploring Effective Paths for Cultivating College Students’ Intercultural Communication Competence – Review of “Research on the Cultivation of Intercultural Communication Competence in English Teaching”. *China Higher Education Science and Technology*, 2022(11): 103–103.
- [11] Wang S, 2023, The Dilemma and Exploration of College English Teaching Reform – A Review of “Reform of College English Teaching from the Perspective of Intercultural Communication”. *Foreign Language Audio-Visual Teaching*, 2023(1): 88–89.
- [12] Lu D, 2021, Research on the Path of Integrating Traditional Chinese Culture into College English Teaching. *Journal of Hubei Correspondence University*, 34(15): 160–162.
- [13] Tan A, 2018, College English Research on the Cultivation of Intercultural Communicative Competence in Teaching. *Overseas English*, 2018(6): 63–65.
- [14] Yang N, 2023, Exploring and Analyzing the College English Education Model Based on the Cultivation of Intercultural Communicative Competence. *Journal of Suzhou Teachers College*, 17(5): 75–77.
- [15] Xu X, 2022, Research on the Cultivation of Intercultural Communicative Competence in College English Teaching. *Chinese Science and Technology Journal Database (Full Text Edition) Education Science*, 2022(5): 87–89.

Publisher’s note

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



Integrated Services Platform of International Scientific Cooperation

Innoscience Research (Malaysia), which is global market oriented, was founded in 2016. Innoscience Research focuses on services based on scientific research. By cooperating with universities and scientific institutes all over the world, it performs medical researches to benefit human beings and promotes the interdisciplinary and international exchanges among researchers.

Innoscience Research covers biology, chemistry, physics and many other disciplines. It mainly focuses on the improvement of human health. It aims to promote the cooperation, exploration and exchange among researchers from different countries. By establishing platforms, Innoscience integrates the demands from different fields to realize the combination of clinical research and basic research and to accelerate and deepen the international scientific cooperation.

Cooperation Mode



Clinical Workers



In-service Doctors



Foreign Researchers



Hospital



University



Scientific institutions

OUR JOURNALS



The *Journal of Architectural Research and Development* is an international peer-reviewed and open access journal which is devoted to establish a bridge between theory and practice in the fields of architectural and design research, urban planning and built environment research.

Topics covered but not limited to:

- Architectural design
- Architectural technology, including new technologies and energy saving technologies
- Architectural practice
- Urban planning
- Impacts of architecture on environment

Journal of Clinical and Nursing Research (JCNR) is an international, peer reviewed and open access journal that seeks to promote the development and exchange of knowledge which is directly relevant to all clinical and nursing research and practice. Articles which explore the meaning, prevention, treatment, outcome and impact of a high standard clinical and nursing practice and discipline are encouraged to be submitted as original article, review, case report, short communication and letters.

Topics covered by not limited to:

- Development of clinical and nursing research, evaluation, evidence-based practice and scientific enquiry
- Patients and family experiences of health care
- Clinical and nursing research to enhance patient safety and reduce harm to patients
- Ethics
- Clinical and Nursing history
- Medicine



Journal of Electronic Research and Application is an international, peer-reviewed and open access journal which publishes original articles, reviews, short communications, case studies and letters in the field of electronic research and application.

Topics covered but not limited to:

- Automation
- Circuit Analysis and Application
- Electric and Electronic Measurement Systems
- Electrical Engineering
- Electronic Materials
- Electronics and Communications Engineering
- Power Systems and Power Electronics
- Signal Processing
- Telecommunications Engineering
- Wireless and Mobile Communication

