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AI-Enabled Reform of Field-Based Teaching for Geological Disaster Prevention and Mitigation under the OBE Framework

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Abstract

Geological disaster prevention and mitigation is a fundamental task for safeguarding human lives and property. With the rapid expansion of the socio-economic system, anthropogenic impacts on the geosphere have intensified, leading to increased occurrence frequency and hazard intensity of geological disasters. Traditional geological disaster prevention methods primarily rely on manual surveys and empirical judgments, resulting in issues such as low efficiency, high costs, and poor accuracy. Meanwhile, the current field-based course on "Geological disaster prevention and mitigation " exhibits a lack of curriculum diversification, pedagogical obsolescence, and a deficiency in students' practical competence. To address these issues, this study proposes a restructured curriculum framework guided by Outcome-Based Education (OBE) and empowered by artificial intelligence (AI). In recent years, the rapid advancement of artificial intelligence (AI) technology has provided new approaches and tools for geological disaster prevention and mitigation. This study aims to explore how AI technology can be integrated into the field practice course on " Geological Disaster Prevention and Mitigation." Through innovations in teaching content and practical instruction, it seeks to enhance practical skills and scientific literacy.

Keywords

Geological disaster prevention and mitigation; Artificial Intelligence (AI); Outcome-Based Education (OBE); Field-based practice curriculum; Curriculum innovation

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1. Introduction

Geological disaster prevention and mitigation represent one of the key applied fields of Earth sciences and serve as a crucial measure for safeguarding human lives and property. They also constitute an integral component of the national strategy for "Holistic security and comprehensive emergency response." Geohazards are among the most pressing global challenges, and their frequent occurrence poses significant threats to human life, property, and the natural environment. Strengthening geological disaster prevention and mitigation efforts is therefore essential for ensuring national security and protecting public safety[1].

Traditional approaches to geological disaster prevention and mitigation have primarily relied on empirical knowledge and conventional technical measures. However, with the exponential growth of data and the rapid advancement of information technologies, the integration of artificial intelligence (AI) into geohazard management has attracted increasing attention. By leveraging big data analytics, machine learning, and deep learning techniques, AI can significantly improve the accuracy of disaster prediction, optimize response strategies, and ultimately mitigate the losses caused by geohazards[2].

With the growing national emphasis on geological disaster prevention and mitigation, the cultivation of skilled professionals in this field has become increasingly critical[3]. However, the traditional field-based course on "Geological Disaster Prevention and Mitigation" faces several challenges, including a lack of curriculum diversification, outdated pedagogical approaches, and insufficient opportunities for students to develop practical competence. Therefore, integrating artificial intelligence (AI) technologies into this field practice course and carrying out instructional reform and innovation not only fosters innovative thinking and hands-on abilities but also carries substantial practical significance and theoretical value for advancing geohazard education.

2. Analysis of the current status of the "Geological Disaster Prevention and Mitigation" field practice course

2.1. Single and limited teaching content

Traditional field practice courses on "Geological Disaster Prevention and Mitigation" mainly focus on the identification and monitoring of geological hazards, with insufficient emphasis on fostering students' innovation and hands-on abilities. In addition, the teaching content is often limited to common geological hazard types such as landslides and debris flows, while more complex hazards, such as earthquake-related disasters, lack in-depth practical teaching and research.

2.2. Outdated teaching methods

Traditional "Geological Disaster Prevention and Mitigation" field practice courses are typically delivered through teacher-centered lectures with students merely observing, which results in a lack of interactivity and hands-on engagement. Moreover, due to the complexity and hazards of geological disaster prevention work, students often have limited opportunities for direct participation and practice, leading to suboptimal teaching outcomes[4].

2.3. Insufficient student practical skills

Due to limitations in teaching content and methods, practical skills are often inadequate. When confronted with real-world geological hazards, students often lack the problem-solving skills and innovative thinking required. Therefore, it is necessary to reform and innovate the field practice course on "Geological Disaster Prevention and Mitigation" to enhance practical abilities and innovative capabilities[5].

3. Application of Artificial Intelligence in Geological Disaster Prevention and Mitigation

3.1. Data processing and analysis

With the advancement of remote sensing and geographic information technologies, geological hazard data continue to expand. AI technologies can efficiently process and analyze this data, extracting valuable information. For instance, machine learning algorithms can classify and cluster historical disaster records to identify patterns and trends[6]. Fan Xuanmei, in the Youth Scientist Forum, presented a case study on using AI for geological disaster data processing, demonstrating how data analysis can improve the accuracy and timeliness of disaster early warning systems[7]. Specifically, machine learning algorithms can extract key features from large datasets and build predictive models, enabling early warning of potential disaster risks.

3.2. Disaster prediction and early warning

AI technology has demonstrated outstanding performance in disaster prediction and early warning. By developing predictive models trained on historical data, AI can identify potential geological hazards in advance[8]. For example, deep learning-based models can integrate multiple data sources, such as meteorological data, topographical data, and geological data, to conduct comprehensive analyses and predict the probability and impact scope of disasters. Professor Zhou Limin's study proposed that AI-based disaster management should encompass six core dimensions: platform, tools, geography, simulation, decision-making, and society, underscoring the importance of human-machine collaboration in complex and dynamic disaster scenarios[9]. These models enable real-time monitoring and timely alerts, providing a scientific foundation for disaster preparedness and response.

3.3. Disaster identification and assessment

AI technologies are also widely applied in disaster identification and assessment. Using image recognition and natural language processing, AI can rapidly analyze visual and textual information from disaster sites to evaluate the severity of events. For instance, high-resolution drone imagery combined with deep learning algorithms can automatically detect hazards such as landslides, debris flows, and collapses, providing timely information to support disaster relief efforts[10]. Fan Xuanmei's research demonstrated that integrating remote sensing imagery with human cognitive modeling significantly improves the accuracy and efficiency of disaster identification[7]. These applications not only accelerate the recognition process but also substantially reduce the error rate associated with manual assessments.

4. Reform and innovation of the Geological Disaster Prevention and Mitigation Field practice course based on the OBE concept

4.1 OBE educational concept

Outcomes-based education (OBE) is a student-centered, learning-outcome-oriented educational philosophy [11] (**Figure 1**). OBE emphasizes that teaching design should focus on the ultimate learning outcomes students are expected to achieve, highlighting process management and continuous improvement. This approach requires instructors to clearly define course objectives, design well-structured teaching activities, and assess students' learning outcomes through effective evaluation methods[12]. The core idea of OBE is to ensure that every student acquires the essential knowledge and skills necessary to perform competently in real-world tasks[13]. In the "Geological Disaster Prevention" field practice course, the OBE philosophy serves as a guiding framework to define course objectives aimed at developing practical abilities in disaster identification, monitoring, assessment, and mitigation, thereby preparing them to address complex

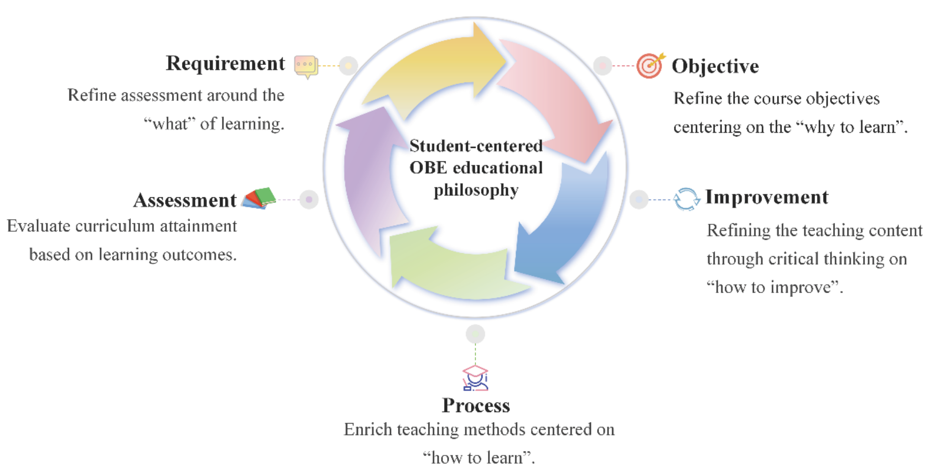

Figure 1. Implementation framework of the OBE educational concept.

engineering geological challenges in future disaster prevention work[14].

4.2. Innovation in teaching content

4.2.1. Integrating typical geological and seismic disaster cases into teaching content

In the "Geological Disaster Prevention" field practice course, representative cases of various geological and seismic disasters should be incorporated into the curriculum. By introducing the types, causes, impacts, and mitigation measures of geological disasters, students can gain a comprehensive understanding of the fundamental theories and practical skills of disaster prevention[15]. At the same time, knowledge related to earthquake monitoring, early warning, risk assessment, and emergency response should be included, enabling students to develop stronger competencies in earthquake disaster prevention and mitigation[16].

4.2.2. Integrating AI applications in Geological Disaster Prevention and Mitigation

The "Geological Disaster Prevention" field practice course should fully incorporate applications of AI technologies in this field. By introducing case studies and underlying principles of AI in disaster monitoring, early warning, risk assessment, and emergency response, students can gain a deeper understanding of the critical role and future potential of AI in geological disaster prevention and mitigation[17]. Furthermore, students should be guided to explore how AI can be applied in real-world disaster prevention practices, thereby fostering innovative thinking and enhancing their practical problem-solving skills.

4.3. Innovation in teaching methods

4.3.1. Integrating AI into VR and AR to enhance field teaching

In the "Geological Disaster Prevention" field practice course, VR and AR technologies can be employed to simulate geological disaster scenarios and support field-based teaching. This approach maximizes student safety during practical training while enriching the overall learning experience. Immersive VR and AR environments allow students to observe the occurrence of geological disasters and the implementation of mitigation measures as if they were on-site, thereby improving interactivity and experiential engagement. Furthermore, incorporating AI for intelligent analysis and optimization of VR or AR scenarios can further enhance instructional effectiveness and create a more dynamic learning environment[18].

4.3.2. Selection and optimization of field routes

In the Geological Disaster Prevention field practice course, field routes should be carefully selected and optimized. Representative geological disaster sites should be chosen for field investigation and observation based on the types and spatial distribution of hazards. At the same time, factors such as actual conditions, weather, and specific teaching objectives should be considered to adjust and refine the routes. This ensures that students gain a comprehensive understanding of the fundamental theories and practical skills required for geological disaster prevention.

4.3.3. Introducing AI-based intelligent evaluation and grading systems

In the Geological Disaster Prevention field practice course, AI-powered evaluation and grading systems can be introduced. By automatically assessing students' notebooks, mapping results, and practical reports, such systems can provide an objective reflection of learning outcomes and practical skills. In addition, AI can be used to analyze learning processes and deliver real-time feedback, enabling them to identify and correct problems promptly, thereby improving both learning effectiveness and overall instructional quality.

5. Challenges and countermeasures

5.1. Technological challenges

(1) Data Quality and Model Accuracy

The construction of virtual field environments and route optimization models relies heavily on large volumes of high-quality data. However, field data are often subject to measurement errors and incompleteness. To address this, it is essential to establish rigorous data quality control protocols and continuously refine AI algorithms to enhance model accuracy and reliability[19].

(2) Enhancement of Intelligent Evaluation Systems

Current AI-driven evaluation systems may struggle to accurately interpret descriptions of complex geological phenomena or assess innovative practices. Continuous improvements in natural language processing and image recognition algorithms are required, supported by domain expert input, to progressively optimize evaluation rules and models for more precise and fair assessment.

5.2. Faculty competence challenges

Faculty members are expected to master emerging technologies such as AI, VR, and AR, along with the corresponding pedagogical approaches. However, some instructors may face difficulties with technology adoption and practical application. To address this issue, universities should strengthen faculty development programs by offering targeted technical training and organizing teaching workshops. Encouraging instructors to actively engage in hands-on practice and innovation can enhance both their pedagogical skills and technological proficiency.

5.3. Cost challenges

Integrating AI, VR, and AR technologies into the curriculum requires significant investment in both hardware and software, including high-performance computing equipment, VR headsets, and specialized software platforms. In addition, there are ongoing costs for system upgrades and technical maintenance. To mitigate these challenges, institutions and relevant departments should actively seek governmental and societal funding support, strategically allocate financial resources, and gradually improve the construction of teaching infrastructure[20].

6. Conclusion

This study explores the application and innovation of artificial intelligence technologies in the field-based course “Geological Disaster Prevention and Mitigation.” By examining the limitations of traditional teaching approaches and the advantages of AI integration, it proposes a series of instructional reforms, including innovations in course content and teaching methodologies.

Artificial intelligence not only enhances the efficiency of data collection and processing but also plays a crucial role in risk assessment, early warning, and emergency response. Its integration into the “Geological Disaster Prevention” and “ Mitigation field course can significantly improve both instructional efficiency and hands-on capabilities, while simultaneously strengthening their safety awareness and innovative thinking. By combining AI with VR or AR-assisted teaching, optimizing field routes, and implementing intelligent assessment of fieldwork outcomes, the course can better align with national strategic needs and embody the OBE educational philosophy. This approach ultimately elevates teaching quality and cultivates highly skilled professionals in the field of geological disaster prevention and mitigation.

Despite the challenges related to technology, faculty competence, and implementation costs, these issues can be progressively addressed through well-designed strategies, driving the Geological Disaster Prevention and Mitigation field course toward greater intelligence and efficiency. Such efforts will contribute to safeguarding national geological security and protecting lives and property. Looking ahead, as AI technology continues to advance, its applications in geological disaster prevention will become even more extensive. This calls for deeper interdisciplinary integration and sustained innovation to accelerate the development of next-generation techniques for disaster prevention and mitigation.

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Research on the Practical Teaching System of Internet of Things Engineering Major Based on the Training Mode of Engineering and Technological Talents

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Abstract

Under the background where the cultivation of engineering and technological talents has become the core orientation of higher education, the optimization of the practical teaching system for the Internet of Things (IoT) Engineering major plays a crucial role in promoting the high-quality development of the discipline and adapting to industrial demands. Based on the core objectives of cultivating engineering and technological talents, this paper clarifies the value of practical teaching in the IoT Engineering major in responding to national strategies, conforming to the interdisciplinary characteristics of technologies, and enhancing students' employability. It analyzes the current problems existing in the practical teaching of this major, such as the disconnection between content and industry, insufficient platform resources, a single teaching method, and an unscientific evaluation system. Strategies are proposed, including reconstructing the practical content of industry-education integration, building a virtual-real integrated teaching platform, implementing a project-driven teaching method, and establishing an evaluation mechanism that emphasizes process and results. These efforts aim to construct a practical teaching system that meets the needs of cultivating engineering and technological talents, and realize the coordinated development of education and industrial progress.

Keywords

Engineering and technological talents; Internet of Things engineering; Practical teaching system; Industry-education integration; Project-driven

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1. Introduction

As a core component of the new generation of information technology, IoT technology has been deeply integrated into fields such as intelligent manufacturing, smart agriculture, and smart cities, and has become an important engine driving the development of the digital economy. Engineering and technological talents are the core force for technology implementation and industrial innovation, and the quality of their cultivation is directly related to the development level of the IoT industry. As the main position for cultivating talents in this field, the IoT Engineering major regards practical teaching as a key link connecting theoretical knowledge and engineering application, and also as the core path to achieve the goal of cultivating engineering and technological talents [1]. Currently, in the process of carrying out practical teaching in the IoT Engineering major in colleges and universities, affected by factors such as traditional teaching concepts, resource allocation, and the degree of industrial connection, some institutions still have problems such as outdated teaching content, insufficient platform support, and weak cultivation of students' innovative ability, which make it difficult to fully meet the cultivation requirements of engineering and technological talents who emphasize practice, excel in application, and are good at innovation. Based on this, guided by the training mode of engineering and technological talents, conducting a systematic study on the construction path of the practical teaching system for the IoT Engineering major is of great practical significance for solving current teaching pain points, improving the quality of talent cultivation, and promoting the accurate connection between the education chain and the industrial chain. It also provides a reference for the practical teaching reform of similar majors.

2. The necessity of cultivating IoT engineering and technological talents

2.1. Demands of national strategies and industrial development

China's "14th Five-Year Plan" clearly incorporates the development of the IoT industry into the national strategy and proposes to promote the in-depth integration of IoT and the real economy. At present, the scale of the IoT industry continues to expand, and there is a significant shortage of supply of scientific and technological talents with engineering practice capabilities. The demand for related positions will continue to grow in the next five years [2]. As the core position for talent cultivation, colleges and universities' IoT Engineering majors need to strengthen the cultivation of engineering and technological talents under the guidance of national strategies. By optimizing the practical teaching system, they can provide suitable professional talents for the industry, assist in the implementation of the digital economy strategy, and promote the IoT industry to move from technological research and development to large-scale application.

2.2. The interdisciplinary and integrative characteristics of IoT technology

IoT technology covers the perception layer, network layer, and application layer, involving multiple disciplinary fields such as electronic information, computer science, and communication engineering, presenting the characteristics of "interdisciplinarity and strong integration". This characteristic requires relevant talents to not only master a single technology but also can integrate and apply multiple technologies. Traditional theoretical teaching makes it difficult for students to understand the technical connection, logic, and engineering scenario application. Through practical teaching, students can complete the whole process of sensor selection, communication protocol debugging, and application system development in a simulated or real engineering environment, realizing the transformation from single technology learning to multi-technology integration application, and meeting the ability requirements of the integration and intersection of IoT technologies.

2.3. Enhancing students' core employability

In the current job market, enterprises' recruitment standards for IoT positions focus more on engineering experience and project capabilities, and graduates who only master theoretical knowledge find it difficult to meet the requirements. Under the guidance of engineering and technological talent cultivation, practical teaching enables students to come into contact with real engineering cases and accumulate project development experience through links such as project training and enterprise internships. For example, by participating in projects such as smart agriculture sensor deployment and industrial IoT data acquisition system development, students can master the complete process of demand analysis, scheme design, and system debugging, form personal project achievements, enhance their core employability, achieve a smooth transition from campus to workplace, and shorten the enterprise training cycle [3].

3. Current situation of practical teaching in the IoT engineering major

3.1. Disconnection between practical teaching content and industry

The update of practical teaching content in the IoT Engineering major of some colleges and universities is lagging, and it still focuses on basic confirmatory experiments, such as the performance test of a single sensor and the verification of a simple communication protocol, lacking comprehensive projects that match the actual needs of the industry. For example, in the teaching of the perception layer, only the measurement of sensor parameters is focused on, without involving the anti-interference design in industrial scenarios; the teaching of the application layer stays in the development of basic APPs, without integrating cutting-edge content such as edge computing and AI model deployment. At the same time, the connection between teaching content and industry standards and enterprise technical routes is insufficient. Most of the textbook cases are limited to the laboratory environment, without considering factors such as environmental complexity and cost control in actual engineering. As a result, students need to re-adapt to the enterprise technical system after graduation, and there is a significant gap between them and the job requirements.

3.2. Insufficient practical teaching platforms and resources

The weak supporting capacity of practical teaching platforms is a common problem. In terms of hardware, some institutions still use old sensors and communication modules, which cannot support the practice of new-generation technologies such as 5G and LoRa. Most laboratories adopt a layout of one device per person, lacking a system-level development environment, making it difficult to carry out comprehensive projects such as IoT system integration and debugging. In terms of software, laboratories mostly use open-source tools, without introducing enterprise commonly used development platforms such as Huawei IoT Studio and Alibaba Link Develop, making it difficult for students to be familiar with the actual development process. In addition, due to funding and regional restrictions, local colleges and universities have an insufficient number of off-campus practice bases, and their cooperation with enterprises mostly stays on the surface. Students lack the opportunity to contact the real engineering environment, and practical activities are limited to the campus.

3.3. Single teaching method and weak cultivation of innovative ability

Most institutions still adopt a one-way teaching mode where teachers demonstrate and students imitate. The process is fixed as teachers prepare experimental steps, students operate according to the instruction manual, and submit reports. In this mode, students are in a passive acceptance state and do not need to independently think about core engineering issues such as technology selection and problem troubleshooting [4]. For example, in the IoT node design course, teachers provide hardware schemes and code frameworks in advance, and students only need to complete welding and code copying, making it difficult to form systematic thinking. Most practical tasks are carried out in the form of individuals, lacking team cooperation on projects. Students cannot cultivate the ability of division of labor, cooperation, communication, and coordination. When facing complex engineering problems, their ability to independently analyze and innovate design is weak.

3.4. Unscientific assessment and evaluation system

The assessment and evaluation have the drawbacks of "emphasizing results over process" and "emphasizing theory over practice." Most institutions take experimental reports as the main basis for assessment, and the evaluation criteria focus on the completeness of the format and the accuracy of data, ignoring students' operational ability, thinking process, and problem-solving ability. For example, even if students make frequent mistakes in the experiment, they can still get high scores as long as they finally complete the report by imitation, which cannot reflect their real practical level. Some assessments still focus on theoretical written tests, examining content such as sensor principles and protocol definitions, which are disconnected from practical operations. In addition, the innovation dimension is not included in the assessment. The optimization schemes or innovative designs proposed by students are not recognized, which makes it difficult to stimulate their innovation enthusiasm and also unable to fully evaluating the effect of practical teaching.

4. Construction of a Practical Teaching System for IoT engineering major based on the training mode of engineering and technological talents

4.1. Reconstructing the Practical Teaching Content System of Industry-Education Integration

To cultivate engineering and technological talents as the core, combined with the technical trends of the IoT industry and the job requirements of enterprises, a four-level progressive practical teaching content system is constructed, including basic experiments, comprehensive training, engineering practice, and innovation incubation. The basic experiment level focuses on the verification of core technical principles, integrates courses such as electronic circuits and sensor technology, and sets up experiments such as "sensor data acquisition" and "ZigBee protocol communication" to consolidate basic operation capabilities. The comprehensive training level is oriented to system design, introducing projects adapted from real enterprise cases, such as the smart classroom environment monitoring system, requiring students to complete the whole process design from demand analysis to deployment [5]. The engineering practice level relies on school-enterprise cooperation, arranging students to participate in actual enterprise projects to be familiar with engineering specifications and development processes. The innovation incubation level encourages students to carry out innovative designs around industrial pain points through discipline competitions and innovation and entrepreneurship projects. In addition, a teaching guidance committee composed of college teachers and enterprise technical backbones is established to update the teaching content every semester, and incorporate cutting-edge technologies such as 5G + IoT, edge computing, and IoT into the training module, ensuring that the teaching content is synchronized with industrial technologies and realizing demand-oriented teaching under industry-education integration[6].

4.2. Building a Virtual-Real Integrated Practical Teaching Platform and Resources

Centering on the practical teaching content system, a three-in-one teaching platform consisting of on-campus laboratories, off-campus practice bases, and virtual simulation platforms is constructed to provide support for the cultivation of engineering and technological talents. On-campus laboratories are built in modules. An IoT system integration laboratory across modules is built to provide a system-level development environment to meet the needs of comprehensive training. The construction of off-campus practice bases focuses on both quality and efficiency. Long-term cooperation is established with local IoT enterprises and intelligent manufacturing parks, and targeted training agreements are signed. Enterprises provide practical positions and assign technical mentors, and colleges and universities adjust the teaching content according to the needs of enterprises to realize order-based training. In view of regional restrictions or the confidentiality requirements of enterprise projects, a virtual simulation platform is built. Using VR/AR technology to simulate scenarios such as industrial IoT workshops and smart city control centers, virtual training projects such as IoT equipment fault diagnosis and large-scale sensor network optimization are developed. Students can experience complex problems in the real engineering environment through immersive operations, making up for the shortcomings of the physical platform [7]. In addition, a practical teaching resource sharing platform is built to integrate resources such as experimental instruction manuals, enterprise technical documents, project case videos, and development toolkits for students' independent learning, breaking the limitations of time and space and improving the efficiency of resource utilization [8].

4.3. Implementing a diversified teaching method driven by projects

Abandoning the traditional teacher-led teaching mode, with projects as the core carrier, a diversified teaching method featuring project-driven, case teaching, and group cooperation is implemented to give full play to the dominant role of students and cultivate the practical ability and innovative thinking required by engineering and technological talents. Project-driven teaching runs through the entire process of practical teaching. Teachers design project tasks of different difficulties according to the objectives of different teaching stages, and clarify the project requirements, delivery standards, and evaluation indicators. In the basic experiment stage, small sensor data acquisition projects are designed, and students independently select sensors, design acquisition schemes, and write data processing codes [9]. In the comprehensive training stage, projects adapted from real cases are adopted, such as simplifying the enterprise's smart warehouse goods positioning system into a teaching project. Students complete the scheme design, hardware selection, system development, and debugging in the form of teams, and teachers only guide key links to guide students to solve problems independently. Case teaching focuses on linking theory with practice. Teachers introduce typical cases in the IoT industry, such as JD's unmanned warehouse IoT system and Wuxi's smart city project. By analyzing the technical architecture, implementation path, and engineering difficulties in the cases, students can understand the application logic of technology in actual scenarios. Group cooperative teaching is carried out in groups of 3–5 people, with clear division of roles such as team leader, technical development, and document writing, simulating the operation mode of enterprise project teams [10]. This not only cultivates students' abilities of communication, coordination, division of labor, and cooperation, but also stimulates their innovative thinking through in-group discussions and inter-group competitions, encouraging them to propose differentiated solutions. In addition, enterprise technical experts are invited to conduct enterprise lectures. Through a combination of online and offline methods, they explain cutting-edge industrial technologies and project practical experience, such as industrial IoT equipment anti-interference design skills and IoT system security optimization cases, to broaden students' engineering horizons [11].

4.4. Establishing a comprehensive evaluation mechanism emphasizing both process and results

Breaking the single evaluation mode centered on experimental reports, a three-dimensional comprehensive evaluation mechanism, including process evaluation, result evaluation, and ability evaluation, is constructed to fully reflect students' practical ability and innovative ability and ensure the quality of engineering and technological talent cultivation. Process evaluation runs through the entire process of practical teaching [12]. Relying on the smart teaching platform, students' participation is recorded, including the standardization of experimental operations, the completion degree of project progress, the contribution degree of team cooperation, and the initiative of problem-solving. For example, in the process of project development, teachers evaluate the depth of students' participation in links such as demand analysis, scheme design, and system debugging by checking students' code submission records, group meeting minutes, and problem debugging logs. By introducing the student mutual evaluation mechanism, team members score each other according to the completion of their assigned tasks and their performance in communication and cooperation, ensuring the objectivity of the evaluation. Result evaluation focuses on engineering practicality [13]. Instead of only focusing on the accuracy of experimental data or the completeness of reports, it takes the function realization degree, engineering standardization, and innovative value of project results as the core indicators. Ability evaluation focuses on the core abilities of engineering and technological talents, and sets three evaluation dimensions: problem-solving ability, system design ability, and innovative ability.

5. Conclusion

Constructing a practical teaching system for the IoT Engineering major based on the training mode of engineering and technological talents is a key path to meet industrial demands, solve teaching pain points, and improve the quality of talent cultivation. By reconstructing the practical teaching content of industry-education integration, building a virtual-real integrated teaching platform, implementing a project-driven teaching method, and establishing an evaluation mechanism that emphasizes both process and results, students' engineering practical ability, system design ability, and innovative ability can be effectively improved, and the core goal of "cultivating engineering and technological talents that meet the needs of the IoT industry" can be achieved.

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A Reflection on Using the L1 and L2 in EFL/ESL Class

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Abstract

The application of the mother tongue in English teaching has long been the focus of debate among educators. Understanding the beliefs of English teachers is helpful for English teachers to realize effective teaching and effective education, and training. This study intends to reflect on whether English teachers use their mother tongue to teach English in class, and the different teaching results brought by using L1 or L2 to teach English. The language used by teachers in classroom teaching is known as "medium of instruction" [1]. In English classroom teaching in China, the use of medium instruction can be divided into three types: English, the combination of English and Chinese, and Chinese. English teachers often think that the use of media language in the classroom will greatly affect the students' English learning. Therefore, there are two views on the use of the medium of instruction: one is to advocate the use of English teaching, and the other is to advocate the proper use of the mother tongue in English classes. These two conflicting views put English teachers in a dilemma. The paper enables teachers to better understand the influence of belief on teaching, and provides some reasonable suggestions and a basis for improving teachers' professional quality.

Keywords

Mainland China; English teacher; L1; L2

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1. Introduction

Some studies have investigated the English teachers' attitudes towards the use of learners' mother tongue [2]. However, few studies have investigated the relationship between teachers' attitudes towards the use of the first language and the actual function of classroom teaching. In the context of teaching in mainland China, most English teachers are not native speakers of English, and the learners' oral English and listening skills are relatively poor. Should the first language be used in English classroom teaching? If so, how often should teachers and students use their native language? If you avoid using the first language, will it help to improve students' listening, speaking, reading, and writing skills?

As language teachers, our teaching goal is to make students learn to use L2. For our teachers' own teaching process, L1 can be used as a teaching tool to achieve the teaching goal of L2. What we should consider, then, is how professional English teachers and educational institutions view the historical use of L1. At the same time, it is necessary to consider our understanding of L1 usage and the evolution of how we have used it over the years [3] to determine the number and function of L1 in ESL environments such as English immersion.

This article will analyze and critically reflect on the above problems based on the literature, and talk about my own beliefs based on my own learning and teaching experience, as well as what I should try or improve in the teaching methods in the future to help teachers and students improve in English learning.

2. Literature review

Since the end of the 18th century, some scholars have advocated that English classroom teaching should focus on grammar and translation, and generally use the first language for teaching. Students' classroom learning activities are mainly to practice and consolidate the learned rules and vocabulary through the mutual translation between their mother tongue and English. This method only focuses on the study of language knowledge and does not pay much attention to using the language in real communicative situations [4]. Hence, Cook and others advocate that English teaching should be widely avoided in learners' first language, so that students can get as many communication opportunities as possible.

When we think about how we learned our first language, we begin by listening and imitating, and when we learn a second language, it's more or less similar to how we learned our first language. Therefore, Krashen [5] believes that in the process of learning a second language, teaching in the mother tongue should be minimized. If the teachers use their mother tongue too much to organize teaching activities, they are actually depriving language learners of many valuable opportunities for second language input. Brown also believes that language acquisition is actually a subconscious activity that can only be realized through the interaction of the second language.

Ellis believes that the use of the first language in the classroom is negative because the characteristics of the use of the first language will be transferred to the second language, and learners are likely to confuse the two languages in the learning process, which hinders the learning of the second language. Some learners, especially adults, even think that it is a waste of time to talk with teachers in their native language in class instead of with native speakers. Krashen also pointed out that "people who learn foreign languages basically do not follow the route of acquiring their mother tongue." Therefore, the use of L1 should be minimized in the learning process.

However, not all researchers support teaching only in a second language in the classroom. Many students in English classes did not have a common mother tongue in the past, and they came from different countries and regions, and the teachers could not speak the students' first language, so they could only teach them in a second language [6]. Monolingual teaching loses its appeal. Therefore, many researchers believe that learners' mother tongue can be used to assist the teaching of the second language, such as grammar point explanation, language analysis, or classroom management. The use of the first language in classroom management can help teachers and students to create a more cohesive and relaxing classroom, which is conducive to improving students' classroom learning efficiency. According to Nunan and Lamb [7], it is practically impossible for learners to completely avoid using their first language in the process of learning a second language, especially for students with a low level of the second language. When foreign language teachers are teaching a second language in their native language, they often feel guilty and think it will hinder students' learning. However, in fact, Copland and Neokleous think it is unnecessary to completely exclude the use of the first language and as long as it is used correctly and appropriately, the first language can actually promote the second language learning of students.

In addition, Janulevicience and Kavaliauskiene then pointed out that no one would argue that human thinking mode is formed by the first language, and the first language always interferes with the foreign language. Auerbach also seems to support this view in her article, holding that students do not consider using a second language at the very beginning, and we should allow them to gradually explore and use a second language based on the basic ideas of using a first language.

3. Reading reflection

As for whether a teacher should teach in the mother tongue or in English in an EFL class, many experts have only outlined some basic arguments for using the mother tongue in a second language class, with some opposing and some in favor. Some ESL/EFL experts support the use of the mother tongue, although some are against it. In this section, I will talk about English teachers' language proficiency, teaching ability, and the relationship between the frequency of L1 in the classroom and teaching results.

3.1. English proficiency and teaching ability

We know that most English teachers around the world use English as their second or third language, not their first language. Namely, the English level of English teachers in each country is uneven, and some English teachers may not be up to the standards of some relevant jobs. Cullen points out that teachers with poor or unskilled oral English will encounter some difficulties in classroom teaching, such as guidance, questioning, explaining the meaning of words, and answering students' questions. A teacher who lacks English language skills will have a severe lack of authority and confidence in the classroom, which will affect his or her performance in all aspects. For non-native English teachers, language competence is always the cornerstone of their professional confidence [8].

In addition to the teachers' language ability, teaching ability is also an important part for the second language teachers. The ability to teach English through English requires a series of related considerations, because in language teaching, language is both the content and the means of teaching. Language knowledge and ability are the core of a language teacher's professional identity. However, language ability and teaching ability are not the same thing. The distinction between content knowledge and pedagogical knowledge and competence is defined as the distinction between declarative and procedural knowledge, which is described by Prodromou as involving at least three areas [9]:

(1) Knowing about and how to use the target language.

(2) Knowing about and how to call in a culturally appropriate way.

(3) Knowing about and how to behave appropriately in the target language.

In teachers' teaching courses, the difference between content or declarative knowledge and pedagogical or procedural knowledge depends on how the content is presented. For example, grammar class can be used as both content knowledge and teaching knowledge. Teachers choose different teaching methods according to different teaching topics, and the teaching effect will be different. Therefore, we should analyze the language ability and teaching ability of the teacher before considering whether to use English in the classroom.

3.2. The frequencies and models of L1 use in the EFL classroom

In a study by Yan et al. [10], they found that the Chinese students significantly increased the frequency of using L1 in class from junior high school to senior high school, because most students were preparing for the national college entrance examination. Since this test does not test spoken English, and the proportion of the score of listening is lower than that of reading and grammar, the use of L1 will increase.

In addition, the use of the mother tongue actually provides security for students, and this security can enhance their self-confidence. On this point, Auerbach claims that people have gained a sense of security since they began to learn their first language in a natural environment. This sense of security matches the life experience of learners and allows them to express themselves. If we give students such a sense of security in English classes, learners will be willing to try and take risks in English learning. In fact, some students are so shy and anxious in English as a foreign language that they feel embarrassed using English, especially when they make mistakes in English. In this case, L1 can help them; the students will feel more comfortable, so they will finally have the confidence to use English.

However, Swain et al. [11] investigated the frequency of L1 used by students in classroom communication in another study, and found that the frequency of L1 used by students with low levels was higher. This is completely contrary to the above-mentioned results that Chinese students use L1 higher in high school than in middle school. In fact, the frequency of L1 used in class, whether in junior or senior grade, is not affected by language proficiency, but by students' belief in English practice opportunities. As mentioned above, some students and teachers are inclined to take exams, while some students are unwilling to use English for personality reasons. Hence, learners' use of L1 and L2 varies greatly in different teaching contexts, so there is no best or most perfect learning mode.

4. Practical experiences reflection

From an English learner to an English teacher, my learning experiences and teaching experiences will bring me a lot of thinking. The time that the Chinese students spend on English learning from childhood to graduation is more than any non-English-speaking country in the world, maybe, but their English level is still lower than that of any other country in the world. According to official IELTS data in 2017, mainland Chinese candidates ranked 34th in the type of A (academic) test among the global sample of 40 countries and regions, and 35th in the type of G (general) test. In the 2017 TOEFL test, mainland Chinese test-takers ranked only joint 111th out of 169 countries in the world. With a population of 1.4 billion and an economy that has grown rapidly over the past few decades, China has plenty of job opportunities. So, for many Chinese, English is just a threshold for selecting jobs and a skill they can forget once they get the certificate.

According to the report written by Xu [12] after his investigation in the first, second, and third-tier cities in mainland China, English is the major of basic English teachers (80%), followed by education/psychology (10%) and other majors (9%). Foreign language school teacher of the highest academic degree, all teachers have bachelor degree or above, including master's degree (or above) of the proportion is as high as 29%, teachers training institutions of teacher education overall level minimum, about a quarter of the teacher education in the college (and below), elementary school and junior high school teacher ratio were 88% and 96% respectively. According to the survey, 56% of the basic English teachers can teach in English. Whether they can teach in English is obviously related to their educational background, the level of their city, and the type of school they are in. The proportion of teachers with master's degree (or above), bachelor's degree, and college degree who can teach in English is 64%, 59% and 39%, respectively. The proportion of teachers in first, second, and third-tier cities who can teach in English is 69%, 60% and 35%, respectively. Among schools in different categories, teachers in foreign language schools were the most able to teach in English (79 percent), followed by training institutions (59 percent) and primary schools (56 percent). Only 33 percent of teachers in general secondary schools were able to teach in English. In China, there are no spoken English tests and few listening tests, so most English teachers focus on grammar and reading and use Chinese in class. Therefore, it is interesting that many English teachers in China can become English teachers without the ability to teach in English. To sum up, I think that maybe this is one of the reasons why Chinese students have low speaking scores in IELTS. As English teachers, we should first ask ourselves to reach a certain level of language ability, and then know that we have the responsibility to help students get a higher score in such examinations as IELTS. Of course, while helping students, teachers can also improve their language skills.

Although there is no perfect answer to whether to use L1 or L2 in ESL and EFL classes, I personally prefer to use L2 if the students can accept it. Ellis [13] also recognized that the use of L1 or L2 sometimes depends on the teaching context, but he supported teachers to teach in English and encouraged students to communicate in English. They can also use L1 or allow students to use it when they think it might be beneficial to use it for a specific purpose. I quite agree with this view, because in the social context of English teaching in mainland China, oral English is not tested in the exam, and many students just want to get high marks in the exam, so we have to pay attention to the exam results, and will put more emphasis on the teaching of reading and grammar. However, in the future teaching process, I will use L2 to teach. When I need to explain some complicated grammar or sentence structure, I will switch to L1. I should not only pay attention to the examination result, which doesn't include the oral English test, but also to the application of English in real life.

Disclosure statement

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Research on the Improvement of Teaching Ability of College English Teachers in A Digital Environment

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Abstract

The deep integration of digital technologies is reshaping the pedagogical paradigms in university English education, where teacher competency enhancement has become a pivotal factor for improving teaching quality. To address the disconnect between technological empowerment and instructional practices, this study analyzes the dual impacts of digital environments on teachers' professional development. It explores four dimensions of competency: digital literacy, interactive design, innovative assessment methods, and emotional intelligence. Practical approaches are examined through school-based training programs, interdisciplinary collaboration, data-driven iterative processes, and tripartite ecosystem partnerships. The research demonstrates that teacher development must transcend basic technical operations, focusing instead on critical technology integration, dynamic equilibrium in teaching scenarios, in-depth interpretation of process data, and reconstruction of emotional connections in virtual spaces. These elements collectively form an integrated development paradigm where technological empowerment and pedagogical wisdom synergistically converge.

Keywords

Digital environment; College English teachers; Teaching ability improvement

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1. Introduction

Digital technologies have transformed the educational ecosystem of higher education, shifting English classrooms from traditional face-to-face instruction to blended online-offline formats. This transition has fundamentally redefined teachers' roles, pedagogical design principles, and student-teacher interactions. While intelligent technologies now require enhanced digital literacy, cross-media communication skills, and data-driven decision-making capabilities, many educators remain confined to basic tool usage without developing deep teaching innovation. This study examines the internal mechanisms driving teacher competency development, identifies core elements of English teaching proficiency in digital environments, provides theoretical foundations for professional growth, and contributes to substantial improvements in university English education quality.

2. Challenges and opportunities of the digital environment to English teachers' teaching ability

2.1. Challenges

The rapid evolution of digital technologies far outpaces educators' adaptability. With educational platforms and smart tools emerging quickly, teachers must continually invest time mastering new technological frameworks. However, traditional teacher training systems have failed to integrate digital pedagogical competencies into core curricula, leaving many educators struggling with technology implementation. The deeper challenge lies in transforming instructional mindsets: digital environments require educators to evolve from knowledge transmitters to learning designers. This necessitates restructuring course content presentation, designing multimodal learning tasks, and establishing data-driven dynamic evaluation systems, rather than simply replicating offline teaching materials on online platforms [1]. Moreover, students' learning behaviors in digital spaces become more implicit, with attention easily distracted. Teachers can no longer monitor students 'comprehension in real-time as they did in traditional classrooms. Teacher-student interactions shift from face-to-face emotional exchanges to screen-mediated symbolic communication, significantly diminishing classroom immediacy and posing severe challenges to educators' ability to maintain classroom control.

2.2. Opportunities

Digital platforms have shattered geographical barriers, enabling teachers to directly access English teaching videos, corpus resources, and cutting-edge research from top universities like Oxford and Cambridge. This allows for the rapid application of international academic theories in local classroom practices, significantly shortening the transition cycle from theory to practice. Meanwhile, AI-generated learning data provides unprecedented insights for educators. Precise records of pronunciation errors in speech recognition software, pauses in reading platforms, and grammatical weaknesses in writing systems allow teachers to design personalized training programs for students at different proficiency levels, transforming one-size-fits-all teaching into tailored guidance. Furthermore, online academic communities have reshaped professional development pathways. Teachers now engage in real-time discussions with global peers about teaching challenges, participate in cross-border research collaborations, and observe classroom cases from diverse cultural backgrounds. Professional growth has evolved from isolated individual exploration to collaborative sharing and interaction of collective wisdom.

3. The constituent elements of teaching ability of college English teachers in a digital environment

3.1. Digital literacy: From basic operations to critical technology integration

Teachers 'digital literacy has evolved beyond basic software operation skills, with the core competency being the ability to assess the value boundaries of technology in education critically. Educators must evaluate whether intelligent tools genuinely align with language acquisition principles, rather than being swayed by technological novelty to blindly digitize all teaching processes. Deep technical integration capability manifests in teachers' proactive selection, adaptation, or rejection of specific technological tools based on educational objectives. For instance, when cultivating critical thinking, educators recognize that AI-generated standard answers may undermine independent thinking, thus limiting AI tool usage while designing open-ended discussion tasks. Additionally, teachers must possess emergency response skills for technical failures. When platforms crash or network disruptions occur, they should swiftly adjust teaching plans, converting digital resources into offline materials to ensure uninterrupted instructional continuity despite technical issues [2].

3.2. Interaction design: Dynamic balance strategies for blended online and offline teaching

The essence of blended learning lies not in rigidly allocating time between online and offline sessions, but in precisely identifying the optimal medium for different knowledge types. Specifically, procedural knowledge like vocabulary memorization and grammar drills work best on digital platforms where systems provide instant error feedback and personalized exercises, freeing up classroom time for advanced language application. Complex cognitive tasks such as critical reading and academic writing, however, demand face-to-face interactions where teachers can immediately identify students' cognitive blocks and adjust their questioning strategies to overcome barriers. This dynamic equilibrium also involves teachers flexibly adapting teaching scenarios based on real-time feedback. When deep disagreements emerge during online discussions, educators may extend these debates to in-person sessions using non-verbal cues like body language and eye contact to stimulate intellectual exchange, rather than mechanically following predetermined lesson plans.

3.3. Evaluation innovation: Application of process data collection and intelligent analysis technology

Digital technology has transformed educational assessment from outcome-focused to process-oriented tracking. Teachers can now monitor students 'complete writing journeys, including detailed behavioral data such as initial draft completion time, revision frequency, vocabulary substitution patterns, and sentence structure adjustments. These insights reveal authentic writing strategies, like a student's frequent deletion of complex sentences for simpler alternatives, indicating insufficient grammatical confidence. This allows teachers to provide targeted syntactic reinforcement in subsequent lessons. Meanwhile, intelligent analysis converts massive data into visualized learning profiles. Instead of manually reviewing each assignment, the system automatically identifies deviations from normal trajectories. For instance, when a student's online study duration drops sharply over two weeks, teachers can intervene promptly to investigate causes and prevent learning difficulties from accumulating. Furthermore, evaluation granularity expands from overall scores to micro-level skill progression. Students can clearly track changes in specific dimensions like listening comprehension speed and speaking fluency, significantly enhancing their sense of academic control.

3.4. Emotional intelligence: The construction path of emotional connection between teachers and students in a digital environment

The screen barrier diminishes the emotional cues teachers traditionally rely on in classrooms, making it difficult to perceive students 'confusion, anxiety, and burnout through cold text messages or static avatars [3]. To address this, educators need to develop new emotional sensing technologies. For instance, they can actively monitor implicit indicators like students' speaking frequency, response speed, and emotional tone in online discussions, capturing psychological states through digital footprints. Simultaneously, building emotional connections requires teachers to create ritualistic interactions in virtual spaces, such as personalized greetings before each class, regular one-on-one voice chats, and immediate affirmation of progress, to consistently convey attention and expectations. Furthermore, teachers must guard against emotional detachment risks in digital environments. When noticing prolonged inactivity on platforms, they should proactively send private messages instead of waiting for help requests. This transforms passive monitoring into active humanistic care, establishing an emotional bridge across screens between teachers and students.

4. Practical approaches to improving the teaching ability of college English teachers in the digital environment

4.1. School-based training: Workshops on technology applications based on real teaching scenarios

School-based training should address real-world challenges teachers encounter in daily teaching by integrating technology tool learning into specific instructional contexts, rather than providing isolated software operation instruction. Workshop design requires identifying practical dilemmas teachers face during lesson preparation, teaching, and assessment, such as maintaining student engagement in online classes or implementing personalized feedback through digital platforms, and developing tailored training programs accordingly. During the training, participating teachers must bring their current unit content to complete digital instructional design under mentor guidance, including selecting appropriate applications, designing interactive activities, and creating digital materials. Peer observation proves crucial: after a teacher demonstrates their design approach, other participants provide immediate feedback addressing potential classroom management issues or student comprehension barriers in technology application, prompting designers to make real-time adjustments. This hands-on refinement process helps teachers truly understand how technology serves educational objectives, avoiding formalistic tendencies of using technology for its own sake. After the workshop, teachers must implement their designs within the following week, then share classroom implementation outcomes during debriefing meetings to discuss student feedback, technical stability, time allocation, and other practical issues, thereby accumulating valuable experience. For instance, a teacher participating in a workshop learned to use Padlet for post-reading discussions. She designed an activity where students uploaded analyses of novel characters, accompanied by screenshots of textual references. Other students could then comment and interact under others' posts. The teacher utilized the platform's tagging feature to categorize and archive student contributions, exporting the data as formative assessment material afterward. This entire process seamlessly integrated technical features with reading instruction objectives.

4.2. Collaborative innovation: Interdisciplinary teams build digital teaching resource banks

The formation of interdisciplinary teams requires breaking down departmental barriers. English teachers collaborate with educational technology experts, subject matter teachers, and multimedia designers to form fixed working groups, each member assuming distinct roles in resource development. English teachers define language teaching objectives, design task sequences, and control language difficulty gradients. Educational technology experts evaluate interactive designs from a user experience perspective to ensure alignment with cognitive principles. Multimedia designers transform teaching content into visual and dynamic presentations, while subject matter teachers ensure professional accuracy across interdisciplinary themes [4]. Resource repository development cannot be fragmented; teams must establish cyclical collaborative mechanisms. Each resource undergoes multiple rounds of discussions, from topic selection and scriptwriting to material production and final review, where members annotate revisions in shared documents in real time. Design drafts circulate within groups with modification notes to prevent information gaps. Resources must undergo small-scale testing before inclusion, with teams selecting target student groups to collect operational path data, dwell time, and repeated viewing segments. This data informs resource effectiveness evaluation. Quality control mechanisms require complete iteration records for each version, preserving the evolution from initial drafts to revisions and final products to facilitate team reflection on design logic optimization. For instance, English teachers and journalism faculty collaborated to develop a media literacy module for English instruction. The English teachers designed vocabulary learning tasks focused on fake news identification, while journalism instructors provided authentic news case materials. Educational technology experts created interactive decision trees to guide students in verifying information authenticity, and multimedia designers developed a simulated social media interface. Over three weeks, the four teams held five online meetings to refine the module. They addressed issues including case study political sensitivity, language difficulty, alignment with student proficiency, and interactive node design rationality. After initial testing in two classes, the presentation timing of prompts was adjusted based on students' feedback.

4.3. Feedback optimization: Use the learning analysis system to realize the iteration of teaching behavior

The core of applying learning analytics systems lies in transforming previously vague teaching outcomes into visualized data metrics. Educators should develop data interpretation capabilities rather than relying solely on technical reports. Specifically, the platform automatically tracks students' behavioral patterns in learning management systems, including granular details like video completion rates, replay frequency at specific knowledge points, time distribution of online test responses, and discussion participation frequency. After each class, teachers should dedicate time to analyzing backend data, focusing on teaching blind spots revealed by anomalies.

For instance, excessive replay of a video segment suggests unclear explanations, concentrated errors on a particular question indicate conceptual misunderstandings, while persistent silence in discussion forums reflects insufficient inclusivity in participation design. Teachers must compare these anomalies with their lesson plans to identify which sections create comprehension barriers or engagement challenges. Additionally, iterative processes require teachers to maintain teaching logs documenting data-driven adjustments—such as illustrating abstract grammar points with diagrams or modifying discussion questions to lower cognitive barriers. Subsequent teaching implementations should review changes in these metrics to validate adjustments. The system also generates individual learning profiles, enabling teachers to identify students needing extra support and design differentiated learning paths for learners with varying learning styles, rather than pushing uniform content at all.

4.4. Ecological construction: A sustainable development mechanism involving universities, enterprises and teachers

The establishment of a sustainable development mechanism requires clarifying the value contributions of all three parties: universities provide policy support, institutional safeguards, and teaching practice scenarios; enterprises deliver cutting-edge technological products, application training, and real-world business cases; while teachers validate technical effectiveness through practical implementation and provide feedback for improvement. This creates a value loop rather than a one-way supply relationship. Specifically, universities should establish an enterprise access evaluation mechanism to screen partners committed to deep involvement in teaching R&D rather than mere product promotion. When signing long-term agreements, clear boundaries must be defined regarding enterprises 'responsibilities in technology updates, teacher training, and data security to prevent superficial collaborations. Enterprise representatives should not limit themselves to software demonstrations but must conduct classroom observations to identify practical challenges faced by teachers. They should customize functional modules based on specific teaching scenarios—such as developing rapid grouping tools for large classes or designing automated speech evaluation systems for oral training. Teachers assume the role of product testers during implementation, documenting functional defects, operational inconveniences, and technical issues encountered by students, while regularly submitting usage reports to drive educational adaptation improvements [5]. Furthermore, universities should incorporate teachers' participation in product development and collaborative resource-building into performance evaluations, granting corresponding workload recognition or performance incentives to ensure sufficient motivation for collaborative innovation.

5. Conclusion

The digital wave is not a static technological phenomenon. Therefore, teachers 'capacity building cannot rely on single training sessions or short-term programs to achieve fundamental breakthroughs, but must be embedded throughout their entire career as a regular component of teaching practice. The continuous iteration of technical tools requires teachers to maintain an open mindset for lifelong learning, while institutions should establish long-term support mechanisms that shift resource allocation from hardware procurement to deep empowerment of teacher development. The ultimate goal of capability enhancement lies not in technical mastery itself, but in teachers' ability to use digital means to diagnose student needs more accurately and adjust teaching strategies more flexibly, ultimately leading to substantial improvements in language acquisition quality. This allows technology to truly return to its original role as a service supporting educational objectives.

Disclosure statement

The author declares no conflict of interest.

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Master's Degree Students in Engineering Academic and Professional Degrees Quality Comparison of Student Sources

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Abstract

Against the backdrop of rapid expansion in professional master's programs, this study analyzes 48,834 engineering-related academic and professional master's students from 19 universities between 2014 and 2017. Through comparative analysis of two dimensions quality of applicant composition and educational background, the findings reveal that while the overall quality of engineering-related professional master's applicants remained stable, there was a slight decline. Moreover, compared with academic degree programs, engineering-related professional master's applicants showed weaker quality overall. Vertical mobility among applicant groups from different universities became increasingly challenging, with non-"Double First-Class" universities experiencing a general decline in applicant quality. To promote coordinated development of both scale and quality in engineering-related professional master's programs, the study proposes the following recommendations, strengthen quality monitoring and implement quality-based enrollment plan adjustments, explore and practice distinctive training models for specialized engineering master's programs and enhance brand building to attract high-quality applicants actively.

Keywords

Comparison; Engineering; Professional degree; Quality of students

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1. Introduction

The quality of training is the focus of educational resources and activities for professional degree graduate students in universities. The quality of student recruitment has a direct impact on the quality of professional degree graduate training, which is one of the key concerns of universities [1–3]. Establishing quality-oriented enrollment and talent development coordination mechanisms in higher education institutions is a crucial initiative for enhancing the quality of professional degree graduate education. As professional degrees increasingly dominate master's programs with continuously expanding enrollment scales, they accounted for 60% of all master's degree enrollments in 2020 [4].

In this context, does the quality of professional degree graduate students remain stable? What differences exist compared to academic degree graduate students? What patterns emerge in their temporal evolution? These questions are crucial for determining whether professional degree graduate education can achieve coordinated development between scale and quality, providing significant reference value for graduate enrollment policy decisions. Urgent research is needed to address these issues.

Although some scholars have analyzed the quality of professional degree graduate students in specific categories or some universities, there are few empirical studies on big data at the macro level of provinces, especially the comparative study between academic degree and professional degree [5,6]. This paper takes 2014–2017 master's students in engineering academic and professional degrees from 19 universities as the subjects (hereinafter referred to as "students" unless otherwise specified.

This comparative study focuses on big data analysis of graduate admissions for "academic degree "and "professional degree" students in engineering disciplines. By addressing these research questions, the study aims to provide actionable insights for optimizing professional degree graduate enrollment policies and advancing the quality enhancement of professional degree education during China's 14th Five-Year Plan period (2021–2025).

2. Research design

2.1. Construction of a quality evaluation system for academic and professional degree graduate students

Evaluating the quality of graduate student recruitment remains a key challenge in assessing and monitoring postgraduate education quality. To address this, we must first clarify the core question: "What exactly constitutes the quality of graduate student recruitment?" This fundamental inquiry determines both the evaluation criteria and methodologies.

Two prevailing perspectives exist regarding graduate recruitment quality. The first perspective maintains that, as advanced academic programs primarily admitting undergraduate graduates, graduate education quality is intrinsically linked to undergraduate competencies, with key measurement points focusing on knowledge comprehension and practical application. The second perspective, however, argues that according to the "Opinions on Deepening Graduate Education Reform" jointly issued by the Ministry of Education, National Development and Reform Commission, and Ministry of Finance, academic degree programs aim to "enhance innovative capabilities."

In contrast, professional degree programs prioritize "developing career competencies." Consequently, graduate recruitment quality is associated with developmental outcomes, primarily assessed through innovation/entrepreneurship potential, career advancement performance, and research achievements. This study contends that the first perspective overlooks the fundamental distinction between undergraduate and graduate education. whereas undergraduate programs focus on cultivating knowledge comprehension, graduate education emphasizes developing creative knowledge production capabilities. Based on this analysis of undergraduate education, etc.

The current evaluation system for graduate student selection inherently suffers from misalignment between its targets and objectives. The second perspective erroneously conflates the distinction between "quality of incoming students" and "quality of cultivation," overlooking the developmental impact of the training process on graduate students' growth specifically, the value of process-oriented enhancement. The relationship between these two concepts isn't a simple linear correlation, which precisely reflects the essence and significance of education. This paper argues that graduate admissions serve as a bridge between undergraduate and postgraduate education, undertaking dual missions of talent selection and vertical mobility. The quality of incoming graduate students exhibits stage-specific characteristics and temporal validity. The two-stage admission model preliminary exams followed by interviews respects objective talent selection principles, demonstrating scientific rigor and practicality. By analyzing admitted students, this study provides insights into the connotation and extension of "quality of incoming graduate students."

Based on the research of scholars on the evaluation index of student quality, and considering that this paper is a third-party evaluation based on provincial big data, this paper constructs an evaluation index system of graduate student quality including two dimensions: student structure quality and student knowledge quality, as shown in **Table 1** [7–9].

Table 1. Evaluation system of quality of graduate students in academic and professional engineering degrees

Aspect	Measuring point
Quality of student structure	(1) Type of the institution to which the first applicant applies, type of the candidate's source institution, source of the candidate (2) Whether the candidate is a first choice or a local student
Knowledge quality of source material	Overall first test score

Note: This classification categorizes Chinese universities into seven tiers based on their talent cultivation levels: Category A (First-Class University Construction Institutions), B (First-Class University Construction Institutions), C (First-Class Discipline Construction Institutions), D (Non- "Double First-Class" Graduate Education Institutions), E (Non-Graduate Education Undergraduate Institutions), F (Independent Colleges), and G (Vocational Colleges and Other Higher Education Institutions). This paper uses Excel software and SPSS21.0 to process the data.

2.2. Research sample

This study selected 19 regular higher education institutions as research subjects. The composition includes:

(1) 2 Category A institutions (Xi'an Jiaotong University and Northwestern Polytechnical University);

(2) 1 Category B institution (Northwest A&F University);

(3) 4 Category C institutions (Xi'an Electronic Science and Technology University, Chang'an University, Shaanxi Normal University, and Northwest University);

(4) 12 Category D institutions (Xi'an University of Technology, Xi'an University of Architecture and Technology, Shaanxi University of Science and Technology, Xi'an University of Science and Technology, Xi'an Technological University, Xi'an Petroleum University, Xi'an Polytechnic University, Xi'an University of Posts and Telecommunications, Yanan University, Shaanxi University of Technology, Baoji University of Arts and Sciences, and Xi'jing University).

From 2014 to 2017, these institutions collectively enrolled 24,183 academic degree postgraduate students and 24,651 professional degree postgraduate students through national unified examinations, with 32,262 male and 16,572 female students. Detailed statistics are presented in **Table 2**.

As seen from **Table 2**, since 2014, when the enrollment scale expanded by 39.15%, the enrollment proportion of professional degree postgraduates increased rapidly from 40.94% in 2014 to 58.67% in 2017, showing a significant effect of structural adjustment.

3. Results and discussion

3.1. Comparison of the first choice institutions for master's students in academic and professional engineering degrees

Due to their strong research and teaching capabilities, solid social reputation, and excellent employment prospects, Class A, B, and C universities consistently attract outstanding students from other institutions [11]. The admission rate-to-enrollment ratio remains high, indicating intense competition. As shown in **Table 3** and **Table 4**, for Class A universities, the gap between academic degree and professional degree applicants' first-choice institutions is minimal, with nearly all applicants choosing peer-class Class A universities. For Class B universities, the proportion of academic degree applicants first choosing peer-class Class B institutions fluctuates between 64.21% to 85.71%, showing an upward trend, while slightly increasing for Class C institutions. Conversely, the proportion of professional degree applicants first choosing peer-class Class B institutions ranges from 54.96% to 75%, demonstrating a downward trend. Meanwhile, the proportions of applicants first choosing Class A or Class C institutions continue to expand despite fluctuations, reflecting a significant increase in student transfers and persistent enrollment shortages.

Table 2. Enrollment of master's students in academic and professional degrees of engineering from 2014 to 2017

Degree	A class	B class	C class	D class	Total
2014					
Academic degree	1655	217	2062	2453	6387
Professional degree	1109	108	1572	1639	4428
Ratio	1.49	2.01	1.31	1.50	1.44
2015					
Academic degree	1103	271	1589	2679	5642
Professional degree	1277	220	2086	1998	5581
Ratio	0.86	1.23	0.76	1.34	1.01
2016					
Academic degree	1178	255	1898	2604	5935
Professional degree	1294	225	2164	2129	5812
Ratio	0.91	1.13	0.88	1.22	1.02
2017					
Academic degree	1243	266	2010	2700	6219
Professional degree	2150	282	3079	3319	8830
Ratio	0.58	0.49	0.65	0.81	0.70

Table 3. Proportion of first-choice applicants for academic master's degree in engineering (%)

Class	Year	Type of university to apply for in the first choice			
		A class	B class	C class	D class
A class	2014	100	0	0	0
	2015	100	0	0	0
	2016	100	0	0	0
	2017	100	0	0	0
B class	2014	23.04	71.43	5.53	0
	2015	27.68	64.21	8.12	0
	2016	19.61	72.55	7.06	0.78
	2017	7.14	85.71	7.14	0
C class	2014	2.76	0.24	96.99	0
	2015	6.99	0.44	92.57	0
	2016	5.80	0.47	93.73	0
	2017	5.37	0.20	94.43	0
D class	2014	11.99	0.98	10.03	77.01
	2015	11.27	0.86	15.79	72.12
	2016	8.95	0.81	17.86	72.39
	2017	7.67	0.59	12.96	78.78

Table 4. The proportion of master's students majoring in engineering disciplines who apply for their first choice (%)

Class	Year	Type of university to apply for in the first choice			
		A class	B class	C class	D class
A class	2014	99.91	0.09	0	0
	2015	99.92	0.08	0	0
	2016	99.92	0	0.08	0
	2017	100	0	0	0
B class	2014	18.52	75.00	6.48	0
	2015	34.09	55.91	10	0
	2016	24.89	65.33	9.33	0.44
	2017	33.33	54.96	11.70	0
C class	2014	4.52	0.38	95.04	0.06
	2015	5.99	0.34	93.67	0
	2016	7.02	0.51	92.38	0.09
	2017	9.03	0.29	90.00	0.68
D class	2014	15.07	1.16	22.39	61.38
	2015	16.77	1.10	23.52	58.61
	2016	15.55	1.22	24.99	58.24
	2017	11.78	1.60	24.19	62.43

Among students admitted to Category C universities, academic degree candidates predominantly (over 90%) and consistently choose Category C universities as their first-choice institutions, at the same time professional degree candidates also show this pattern, but at a declining rate. Notably, some first-choice applicants now select Category D universities, whereas applications to Category A universities have been increasing. For Category D universities, academic degree candidates maintain a stable 72%–78% first-choice preference for Category D institutions, while professional degree candidates show a significant 58%–62% preference. This data reveals distinct differences between Category B and D universities' admission patterns, particularly regarding first-choice institution preferences.

3.2. Comparison of the sources of graduate students in engineering academic and professional degrees

Candidates from different sources have different professional theoretical bases and different purposes of pursuing graduate study.

The cultivation phase has a direct impact. According to the Ministry of Education's regulations, the sources of master's degree candidates can be categorized into recent undergraduate graduates, higher education teachers, researchers, other working professionals, secondary school teachers, undergraduate students who have completed their studies, and vocational college students. In practice, this article divides the candidate sources into two categories: "fresh graduates" and "others".

As shown in **Table 5**, among students enrolled in Category A universities, the proportion of recent undergraduate graduates in both academic and professional degree programs remains relatively stable, with a gap of approximately 10% between the two categories. In Category B universities, the proportion of recent undergraduates fluctuates significantly between these two degree types, showing an overall downward trend, with some overlap observed between the two

Table 5. Sources of graduate students for academic and professional master's degrees in engineering (%)

Class	Year	Academic degree in engineering		Engineering professional degree	
		Fresh graduate	Others	Fresh graduate	Others
A class	2014	81.39	18.61	71.15	28.85
	2015	82.05	17.95	72.75	27.25
	2016	84.72	15.28	73.18	26.82
	2017	82.62	17.38	69.53	30.47
B class	2014	85.25	14.75	87.96	12.04
	2015	85.24	14.76	87.27	12.73
	2016	89.80	10.2	76.00	24
	2017	85.71	14.29	79.43	20.53
C class	2014	78.81	21.19	76.46	23.54
	2015	81.88	18.12	79.53	20.47
	2016	82.67	17.33	79.81	20.19
	2017	83.68	16.32	78.11	21.89
D class	2014	81.17	18.83	72.73	27.27
	2015	79.47	20.53	75.28	24.72
	2016	80.38	19.62	72.80	27.20
	2017	78.52	21.48	70.44	29.56

categories. For Category C universities, academic and professional degree programs exhibit increasing proportions of recent undergraduates, though the gap remains modest and shows signs of widening. In Category D universities, the proportion of recent undergraduates in academic degree programs is higher than in professional degree programs, indicating a notable difference. Overall analysis suggests that regarding the measurement point of "student source", academic degree programs admit a higher proportion of recent undergraduates than professional degree programs, demonstrating a distinct disparity between the two categories.

3.3. Comparison of graduate students in engineering academic degree and professional degree

As previously mentioned, Class A, B, and C universities maintain high-quality educational standards. Consequently, graduates from these institutions are typically regarded as premium candidates by their respective universities and become prime targets for recruitment. **Table 6** and **Table 7** reveal distinct patterns: In academic degree programs, over 50% of students admitted to Class A universities come from similar-tier institutions, while professional degree programs show a notable preference for graduates from Class D universities.

Data indicate that since 2014, the proportion of graduates from Class A, B, and C universities has been steadily increasing across all academic degree programs. However, the growth rate of academic degree admissions outpaces that of professional degrees. Class B universities exhibit greater diversity in graduate origins, yet academic and professional degree programs maintain Class D universities as their most significant source. For Class C universities, while Class D graduates still dominate academic and professional degree enrollments, their proportion shows a downward trend. Conversely, Class A, B, and C universities demonstrate rising enrollment rates, with academic degree programs surpassing professional degree programs in Class D university representation. Class D universities maintain dominance in academic

Table 6. Source of graduate students for academic master's degree in engineering (%)

Class	Year	A class	B class	C class	D class	E class	F class	G class
A class	2014	44.41	2.72	14.26	34.86	3.02	0.73	0
	2015	60.11	2.36	11.42	23.66	2.09	0.45	0
	2016	63.24	3.40	14.26	17.15	1.87	0.08	0
	2017	62.12	3.62	13.27	19.47	1.45	0	0
B class	2014	3.23	29.03	10.14	49.77	6.91	0.92	0
	2015	1.85	30.26	8.49	54.61	4.06	0.74	0
	2016	1.18	29.41	12.95	52.94	2.35	1.18	0
	2017	0.75	25.19	16.92	52.63	3.38	1.13	0
C class	2014	1.41	1.31	36.42	48.25	9.65	2.96	0
	2015	1.89	1.57	39.27	43.43	10.32	3.52	0
	2016	3.48	1.53	44.73	39.36	9.22	1.69	0
	2017	2.94	1.14	47.56	40.05	7.06	1.24	0
D class	2014	0.61	0.49	2.69	68.12	15.49	12.47	0.12
	2015	0.26	0.37	2.50	71.67	13.25	11.83	0.11
	2016	0.61	0.54	3.23	74.65	12.86	8.10	0
	2017	0.74	0.41	3.19	77.04	10.00	8.48	0.15

Table 7. Source of graduate students for master's degree in engineering (%)

Class	Year	A class	B class	C class	D class	E class	F class	G class
A class	2014	26.24	2.61	14.52	48.42	5.50	2.80	0
	2015	34.69	3.99	14.80	39.94	4.31	2.27	0
	2016	32.15	4.40	14.30	45.05	2.86	1.24	0
	2017	31.67	4.14	19.07	40.28	3.58	1.26	0
B class	2014	3.70	28.70	5.56	48.15	5.56	7.41	0.93
	2015	1.82	28.18	8.64	54.09	4.09	3.18	0
	2016	2.22	22.67	8.00	60.89	4.44	1.78	0
	2017	1.77	26.24	22.7	41.13	7.09	1.06	0
C class	2014	0.95	1.02	27.42	50.13	15.39	5.09	0
	2015	2.11	1.39	33.17	45.64	13.04	4.65	0
	2016	2.96	2.22	37.06	43.35	11.74	2.68	0
	2017	4.09	2.14	35.30	44.17	11.24	3.05	0
D class	2014	0.73	0.61	4.21	56.92	19.65	17.39	0.49
	2015	0.85	0.60	5.11	59.11	17.62	16.22	0.50
	2016	0.85	0.56	3.33	63.22	17.43	14.42	0.19
	2017	0.81	0.81	4.43	62.40	17.69	13.74	0.12

and professional degree admissions, showing consistent growth. Notably, academic degree programs at Class D universities retain a 10% higher proportion of Class D graduates than professional degree programs, highlighting a significant disparity. Overall analysis suggests that in terms of the measurement point of “source graduation unit type”, there are differences between academic and professional degree graduate students.

3.4. Comparison of the first choice rate of graduate students in engineering academic degree and professional degree

Universities with higher first-choice admission rates demonstrate greater initiative in their post-admission selection processes. This enables them to better align student recruitment with disciplinary development needs while maintaining the capacity to refine their admission mechanisms and enhance applicant quality continuously. Conversely, institutions with lower first-choice admission rates face uncertainties in both disciplinary structure and applicant quality. Under pressure to meet enrollment targets, these universities often downplay or superficially conduct post-admission evaluations, which negatively impacts their academic cultivation processes.

As shown in **Table 8**, Category A universities consistently maintain a 100% first-choice rate for academic degree programs, while the first-choice rate for professional degree programs has gradually reached 100%. Category B universities show an increase in academic degree first-choice rates despite fluctuations, whereas professional degree first-choice rates decline with these fluctuations. Category C universities maintain relatively high first-choice rates for academic degrees but exhibit a downward trend for professional degrees. Category D universities demonstrate low first-choice rates for academic and professional degree applicants, with professional degree applicants showing significantly lower first-choice rates than academic degree applicants. Overall, the measurement point of “first-choice rate” reveals distinct differences between academic and professional degree graduate students.

3.5. Comparison of the source rate of master’s students in engineering academic degree and professional degree in our university

When first-choice applicants predominantly apply to higher-tier universities or regions with more developed economies, the university’s domestic student enrollment often represents a high-quality candidate pool for many institutions. Moreover, since these students are more familiar with the institution’s environment, their proportion serves as an indicator of satisfaction and recognition towards their host institutions. As shown in **Table 9**, except for Category B universities, academic

Table 8. First choice rate of graduate students in academic and professional master’s degrees in engineering (%)

Degree	A class	B class	C class	D class
2014				
Academic degree	100	70.51	96.12	74.4
Professional degree	95.31	75	94.4	54.24
2015				
Academic degree	100	63.1	91.32	67.97
Professional degree	99.30	54.09	92.28	51.00
2016				
Academic degree	100	71.37	91.89	68.66
Professional degree	98.84	61.78	90.43	50.49
2017				
Academic degree	100	84.59	93.38	75.70
Professional degree	100	54.26	86.81	56.37

Table 9. Source rate of graduate students in engineering academic degree and professional degree in our university (%)

Degree	A class	B class	C class	D class
2014				
Academic degree	38.55	27.65	30.21	32.74
Professional degree	19.30	25.93	21.50	17.27
2015				
Academic degree	52.77	30.26	33.67	40.46
Professional degree	29.91	27.73	26.27	21.82
2016				
Academic degree	57.22	28.63	37.41	42.93
Professional degree	26.20	22.22	29.53	21.94
2017				
Academic degree	56.07	24.44	38.61	50.63
Professional degree	25.63	24.47	26.05	27.81

degree programs at Category A, B, and D universities demonstrate significantly higher domestic enrollment rates than professional degree programs, with substantial disparities. Overall, the measurement point of "domestic student enrollment rate" reveals apparent differences between academic and professional degree graduate students.

Through comparative analysis of key measurement indicators, including candidates' first-choice institution type, source institution type, candidates' origin, whether as first-choice applicants, and whether from the same university, it was found that while slight variations exist between different types of universities, overall differences in candidate sources between academic and professional degree postgraduate programs are evident across all measured dimensions. Academic degree postgraduate candidates demonstrate relatively higher quality in the "quality of source structure" dimension.

The study also reveals two trends in master's degree applications:

(1) The proportion of candidates applying to Category A, B, and C universities as their first choice shows an expanding trend, with candidates from higher-tier universities rarely applying to lower-tier institutions. This indicates that lower-tier universities will face increasingly severe adjustment challenges, with long-term fluctuations and uncertainties in student sources that will impact the training process;

(2) Comprehensive analysis reveals an expanding trend in the proportion of candidates admitted to their own type of university. at the same time, it becomes increasingly complex to enroll students from higher-tier institutions. The proportion of candidates from Category E and G universities without master's enrollment authority continues to decline, reflecting growing difficulties in vertical mobility among candidates across different types of universities.

3.6. Comparison of preliminary test scores of master's students in engineering academic degree and professional degree

Although there is still controversy whether the preliminary test results can fully reflect the quality of candidates, some studies have shown that the preliminary test results can represent the long-term development potential of candidates to a large extent [12]. Given that fluctuations in the basic requirements for initial exam scores for annual re-admission significantly impact admitted candidates' preliminary performance, this study introduces the "Group Academic Ranking Index" (EI, Excellence Index) to mitigate the influence of extreme high or low scores on overall results. The index aims to reflect the macro-level performance of initial exam scores across different categories of graduate student applicants from various universities [13,14]. The EI index measures the overall improvement in initial exam scores by comparing the top 30% and bottom 30% of examines. It operates through two types: division-based and subtraction-based calculations. When the division-based EI index exceeds 1 (with positive subtraction EI), it indicates strong overall performance. A division-based EI index equal to 1 (negative subtraction EI) suggests average-level performance. Conversely, a division-based EI index below 1 (negative subtraction EI) signals weaker overall exam results.

As shown in **Table 10**, from 2014 to 2017, the enrollment scale of academic degree postgraduate students decreased slightly despite fluctuations, while their initial exam scores remained stable and generally excellent. During the same period, the enrollment scale of professional degree postgraduate students expanded rapidly by 99.41%, but their overall initial exam scores slightly declined.

To better analyze variations in initial entrance exam scores among different types of university applicants, this study calculates and compares EI indices for academic and professional degree graduate students across various institutions. To simultaneously reflect the status of different universities in the admissions process of 19 institutions and their own score fluctuations, we introduce two metrics: overall EI and independent EI.

As shown in **Table 11**, from 2014 to 2017, Category A universities maintained overall stability with slight improvements in the initial exam scores of academic degree graduate applicants. Category B universities remained stable overall. While Category C universities experienced minor fluctuations, their academic degree applicant numbers stayed generally stable. Category D universities showed stability but saw a slight decline. However, when analyzing the performance of these applicant groups across all university categories, Category A universities demonstrated clear advantages, attracting most high-scoring students from their respective provinces. Category B universities exhibited cyclical fluctuations, showing varying levels of performance. Among the 19 universities, Category C universities steadily gained prominence. Conversely, Category D universities faced significant disadvantages, with their numbers declining through fluctuating trends.

As shown in **Table 12**, from 2014 to 2017, regarding the initial exam scores of professional degree graduate applicants, Category A universities maintained relative stability despite expanded enrollment scales. Category B universities generally remained stable, with

Table 10. EI index of initial test scores of master's students in academic and professional engineering degrees

Degree	2014	2015	2016	2017
Academic degree				
Overall number of people	6387	5642	5935	6219
Top 30%	1965	1731	1844	1912
Post-30% number of people	1930	1705	1790	1881
EI index number (division)	1.02	1.02	1.03	1.02
EI index number (subtraction)	0.01	0.01	0.01	0.01
Professional degree				
Overall number of people	4428	5581	5812	8830
Top 30%	1368	1723	1758	2690
Post-30% number of people	1343	1705	1792	2710
EI index number (division)	1.02	1.01	0.98	0.99
EI index number (subtraction)	0.01	0	-0.01	0

Table 11. EI index of initial test scores of master's students in engineering academic degree

EI index	2014	2015	2016	2017
A class				
Divided				
Overall	41.19	848	215.75	27.31
Independent	0.98	0.97	0.95	1.02
Subtraction				
Overall	0.63	0.78	0.73	0.68
Independent	-0.01	-0.01	-0.01	0.01
B class				
Divided				
Overall	0.74	1.65	0.95	1.85
Independent	1	0.98	1.03	1.01
Subtraction				
Overall	-0.09	0.12	-0.01	0.15
Independent	0	1.6	0.01	0
C class				
Divided				
Overall	0.9	1.6	1.34	2.04
Independent	1.01	1.04	0.99	0.98
Subtraction				
Overall	-0.03	0.12	0.08	0.17
Independent	0	0.01	0	-0.01
D class				
Divided				
Overall	0.25	0.22	0.26	0.19
Independent	1.03	1.02	1.01	0.98
Subtraction				
Overall	-0.38	-0.39	-0.36	-0.44
Independent	0.01	0.01	0	-0.01

overall performance being relatively strong. Category C universities demonstrated stable and balanced performance. Category D universities maintained overall stability. However, when analyzing the initial exam scores of applicants across 19 universities, Category A universities still held a dominant position, though their advantage over academic degree programs was less pronounced. The overall competitive edge continued to expand. Category B universities exhibited fluctuating performance with cyclical patterns. Category C universities showed a gradual upward trend. Category D universities remained at a disadvantage and experienced a downward trajectory.

Table 12. EI index of initial test scores of master's students in engineering majors

EI index	2014	2015	2016	2017
A class				
Divided				
Overall	2.81	16.61	16.22	22.86
Independent	1	0.99	0.99	1.03
Subtraction				
Overall	0.38	0.63	0.58	0.59
Independent	0	0	-0.01	0.01
B class				
Divided				
Overall	0.6	0.68	0.44	0.52
Independent	1.03	1.02	0.99	1.05
Subtraction				
Overall	-0.17	-0.11	-0.21	-0.15
Independent	0.01	0	0	0.01
C class				
Divided				
Overall	0.75	0.91	1.04	1.01
Independent	0.99	1	0.99	1.02
Subtraction				
Overall	-0.08	-0.03	0.01	0
Independent	0	0	0	0
D class				
Divided				
Overall	0.44	0.27	0.31	0.24
Independent	0.98	0.98	1	1.02
Subtraction				
Overall	-0.22	-0.35	-0.36	-0.38
Independent	0	-0.01	0	0

4. Conclusions

From 2014 to 2017, the enrollment scale of academic degree graduate students at 19 universities remained relatively stable, while the enrollment scale of professional degree graduate students nearly doubled, indicating the basic completion of structural adjustment goals. This study analyzed big data on academic and professional degree graduate admissions from 2014 to 2017 across these 19 institutions.

Through comparative analysis of six measurement points under two dimensions, "quality of applicant composition" and "knowledge quality of applicants," the findings revealed:

(1) The quality of applicants for engineering-related

academic and professional master's programs remained largely stable, with a slight decline observed in professional master's programs;

(2) Significant differences existed in applicant composition between engineering-related academic and professional master's programs, with professional degree applicants demonstrating lower quality;

(3) Vertical mobility of applicants across different types of universities became increasingly challenging. First-class universities (Group A) and first-class discipline construction universities showed distinct advantages with expanding trends, while Group B first-class universities experienced fluctuations in applicant quality. In contrast, non-"Double First-Class" construction universities exhibited an overall downward trend in applicant quality.

This paper analyzes that the above phenomenon has both historical and realistic reasons:

(1) In early 2011, China's Ministry of Education outlined three strategic objectives for professional degree graduate education reform: structural optimization, model transformation, and brand cultivation. This policy shift led to a rapid expansion in the enrollment ratio of professional degree students. However, this growth has been significantly constrained by exogenous factors such as enrollment policies. The development of professional degree programs suffers from inadequate coordination in educational resources, while their training models remain path-dependent on academic degree frameworks, resulting in a lack of distinctiveness. Moreover, an extensive expansion-driven growth model persists, while macro-level quality control mechanisms remain underdeveloped;

(2) During the 2009 national postgraduate admission review phase, China's Ministry of Education implemented a policy allowing full-time professional master's programs to enroll fresh undergraduate graduates. While the plan initially allocated 50,000 additional spots that year, only 38,000 were ultimately filled exclusively by transfer candidates. Compounded by the perceived social stigma surrounding part-time professional degree programs, this policy created lasting negative impacts on both applicant confidence and the quality of full-time graduate candidates in subsequent years;

(3) The mobility of high-quality students across regions and between universities at different tiers has long been a phenomenon in China's graduate admissions system. In October 2015, the State Council issued the Overall Plan for Coordinating the Development of World-Class Universities and Disciplines, sparking a new wave of university expansion. Implementing proactive measures to attract top-tier students remarkably fresh undergraduate graduates from higher-level institutions has become a key strategy for supporting the "Double First-Class" initiative. This trend has also significantly influenced the recruitment dynamics for professional degree graduate programs.

4.1. Policy recommendations

In September 2020, China's Academic Degrees Committee and the Ministry of Education jointly issued the "Development Plan for Professional Degree Graduate Education (2020–2025)", which underscores the vital importance of advancing this educational model and commits to comprehensively enhancing its quality. Guided by the principle of "cultivating virtue, meeting societal needs, improving quality, and pursuing excellence", the plan emphasizes proactive measures to elevate applicant qualifications, achieve balanced growth in both scale and quality, and accelerate substantive quality development. These objectives constitute a critical mission for China's professional degree graduate education during the 14th Five-Year Plan period (2021–2025). To address these priorities, this paper proposes the following recommendations:

(1) Strengthen quality supervision and evaluation in graduate admissions, with scientific allocation of enrollment quotas. Quality remains the cornerstone of postgraduate selection processes. During the 14th Five-Year Plan period, the continuous expansion of professional degree graduate programs will persistently face resource capacity constraints. Balanced development

between enrollment scale and quality constitutes a crucial responsibility for provincial education authorities. This study reveals growing disparities in student quality across different university types. Enrollment quotas, directly linked to fiscal allocations, also influence resource adjustments in discipline development, faculty teams, and scientific research, serving as an effective regulatory tool for supply-side structural reforms. Given the persistence of extensive expansion models where some institutions prioritize "meeting enrollment targets" over quality, provincial education authorities should implement market-oriented mechanisms. Establishing a quota allocation system based on student quality standards is imperative to break the "only increase, no decrease" mentality, guiding universities toward quality-focused development models. Ensuring stable admission quality now carries both urgency and necessity;

(2) Develop quality-oriented education by exploring distinctive graduate training models for specialized disciplines from the supply side. The ability to attract high-caliber students depend on cultivation models and educational quality. During the "Double First-Class" initiative, some universities have made significant progress in funding, infrastructure, pedagogical approaches, and training systems, gradually aligning with global first-tier graduate education standards. Their enhanced appeal to top students is evident in improved applicant quality. Conversely, other institutions lag, preoccupied with meeting enrollment quotas while neglecting systemic reforms. This results in superficial interview processes and declining overall applicant quality. Therefore, during the 14th Five-Year Plan period, universities should prioritize students' long-term development, enhance their sense of fulfillment, and improve process value-added through supply-side reforms. By leveraging strengths to adapt to new economic trends, emerging technologies, industries, business models, and operational paradigms, institutions can cultivate engineering graduate students with distinctive characteristics. This approach will improve talent cultivation's adaptability, foresight, and leadership potential, establishing a sustainable strategy for attracting top-tier students;

(3) Strengthen brand development and enhance the appeal of specialized degree programs with distinctive advantages. The multi-stakeholder governance model in master's admissions grants universities significant autonomy at the enrollment level. By implementing policies that balance fairness, equity, and quality efficiency, institutions can effectively improve student recruitment standards [15]. During the "Double First-Class" initiative, numerous universities have implemented measures to attract high-quality students, particularly fresh undergraduate graduates from top-tier institutions. While academic research indicates that the type of undergraduate institution affects student quality, practical evidence shows that talent cultivation mechanisms and educational models play a more significant role in shaping the overall quality of education [16]. Therefore, while strengthening the connotation of quality education, universities are advised to enhance brand development and transform enrollment promotion strategies. By adopting student-oriented perspectives through diverse platforms and channels particularly by leveraging high-quality alum networks colleges should actively promote their distinctive academic programs and attract top-tier students.

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Application and Practice of Information Technology in Language and Character Teaching in Colleges and Universities

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Abstract

Against the backdrop of the transformation of digital education, integrating information technology into language and character teaching in colleges and universities is a crucial path to advance teaching reform and improve teaching quality. Based on the actual situation of language and character teaching in colleges and universities, this paper analyzes the role of information technology in enriching the forms of teaching content, stimulating students' learning initiative, and realizing personalized and precise teaching. It also sorts out the current application status, including the popularization of multimedia courseware, the construction of online platforms, the exploration of intelligent speech technology, and the imbalance in resource development. Furthermore, specific application strategies are proposed from four dimensions: deepening technology integration, making flexible use of platform data, introducing intelligent tools, and jointly building and sharing resources. This provides practical references for the digital upgrading of language and character teaching in colleges and universities, and helps to promote the coordinated improvement of students' comprehensive language ability and cultural literacy.

Keywords

Information technology; Colleges and universities; Language and character teaching; Teaching reform; Digital education

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1. Introduction

Language and characters are not only the carriers of cultural inheritance but also the basic content of talent cultivation in colleges and universities. With the advent of the digital era, the traditional teaching mode, which mainly relies on classroom lectures and textbook reading, has gradually shown limitations and is difficult to meet the diverse learning needs and personalized development demands of students. Information technology, with its advantages of resource integration, interactive communication, and real-time feedback, provides a possibility for breaking through the traditional bottlenecks in language and character teaching in colleges and universities [1]. From the early use of multimedia courseware as an auxiliary teaching tool to the current widespread attempts of online teaching platforms, intelligent speech systems, and AI correction tools, information technology is gradually penetrating into all aspects of language and character teaching.

However, in the process of practice, issues such as how to avoid the superficial application of technology, how to deeply integrate technology with teaching objectives, and how to solve the imbalance of teaching resources between regions and schools still need further exploration. Based on this, this paper systematically analyzes the application value, current situation, and strategies of information technology in combination with the characteristics and needs of language and character teaching in colleges and universities, aiming to provide ideas for promoting the high-quality development of language and character teaching in colleges and universities.

2. The role of information technology in language and character teaching in colleges and universities

2.1. Enriching teaching content and forms

Traditional language and character teaching in colleges and universities mostly relies on teaching materials and teachers' lectures, with a single form of content presentation, which is difficult to fully arouse students' sensory experience. Information technology can break this limitation and transform abstract language and character knowledge into intuitive and perceivable teaching resources through the integration of multiple media such as text, images, audio, and video [2]. For example, in literature appreciation courses, teachers can use documentary clips to restore the historical background of the creation of works, analyze the imagery structure of poems through animation demonstrations, and play audio recordings of classic text recitations using audio resources, enabling students to deepen their understanding of the text through an audio-visual integrated experience. Information technology can also link a large number of online resources, such as digital libraries, academic databases, and cultural thematic websites, providing students with extended content beyond the scope of teaching materials, helping them build a more complete knowledge system and broaden their language and cultural horizons.

2.2. Stimulating students' learning initiative

The learning of language and characters requires students to actively participate in thinking and practice. However, the traditional teaching mode, where teachers lecture and students listen passively, easily makes students in a state of passive acceptance, resulting in insufficient learning enthusiasm. Information technology creates opportunities for students to actively participate by building interactive teaching scenarios, effectively stimulating their interest in learning. Functions such as discussion boards, bullet screen interactions, and group collaboration on online teaching platforms allow students to share their interpretations of texts, exchange writing ideas, and even debate on a certain language and cultural topic inside and outside the classroom [3]. This breaks the time and space limitations of the classroom and enhances students' sense of participation. Information technology also supports students to formulate their own learning plans independently. They can arrange their learning progress independently through online course resources, and use interesting designs such as checkpoint answering and point rewards to transform language learning into challenging tasks, further stimulating students' learning motivation and exploration desire [4].

2.3. Realizing personalized and precise teaching

There are significant differences in college students' language foundations, learning abilities, and interest preferences. The traditional teaching mode is difficult to meet the personalized needs of different students. Information technology can accurately grasp students' learning status through data collection and analysis, providing support for personalized teaching. In the pre-class preview stage, teachers can assign preview tasks and test questions through online platforms. The system automatically counts students' answer results and quickly identifies their knowledge weaknesses. For example, in grammar teaching, if most students make mistakes in complex sentence analysis questions, teachers can intensively strengthen this knowledge point in class [5]. In the in-class teaching stage, interactive answering tools can be used to collect students' learning feedback in real time, and the teaching rhythm and depth of content can be adjusted according to students' mastery of knowledge. In the after-class review stage, personalized review resources can be recommended based on students' learning data, improving the accuracy and effectiveness of teaching.

3. The current application situation of information technology in language and character teaching in colleges and universities

3.1. Popularization of multimedia courseware application

At present, multimedia courseware has become a basic auxiliary tool for language and character teaching in colleges and universities. Almost all courses use software such as PPT and Keynote to create courseware, replacing the traditional blackboard writing. Courseware integrates key teaching points, text excerpts, case analyses, and audio-visual materials. In basic Chinese courses, they can display animations of Chinese character stroke sequences; in literature courses, they can present videos related to writers' life stories and works, improving the efficiency of information transmission in the classroom. Most teachers adjust the content of courseware according to the teaching progress and students' feedback, supplementing the latest language application cases or cultural hotspot materials. However, some courseware still remain in the simple combination of "text + pictures", lacking interactive designs. There is even a situation where "courseware replaces lectures", failing to give full play to the advantages of multimedia technology, and the problem of students passively receiving information is still prominent [6].

3.2. Extensive construction of online teaching platforms

Colleges and universities have generally introduced online teaching platforms such as Chaoxing Xuexitong and Rain Classroom, providing diversified support for language and character teaching. Teachers can publish course outlines, preview materials, and after-class assignments on the platforms, allowing students to access resources at any time. The platforms support the submission of electronic assignments and the automatic correction of objective questions, saving teachers' correction time. The discussion board and live broadcast functions can also extend classroom teaching, such as launching discussions on language and cultural topics and conducting lectures on writing guidance [7]. During the epidemic period, the platforms became the core carriers of online teaching, ensuring the continuity of teaching. However, in daily teaching, some students only complete the submission of assignments and the viewing of materials, with low enthusiasm for actively participating in discussions and browsing extended resources. At the same time, some teachers have insufficient development of functions such as platform data statistics and learning situation analysis, only using them for basic resource management, making it difficult to optimize the teaching process.

3.3. Preliminary exploration of intelligent speech technology

Intelligent speech technology has begun to be applied in oral English teaching and speech training, and some colleges and universities have introduced tools such as iFlytek's oral evaluation system. Through speech recognition technology, such systems can conduct real-time evaluation on the accuracy and fluency of students' pronunciation and generate feedback reports [8]. For example, in Chinese oral courses, they can point out problems such as tone deviations and confusion between flat and retroflex sounds, and provide standard pronunciation demonstrations; in Pu Tong Hua proficiency test training, they can simulate the test process to help students familiarize themselves with the test format in advance. In addition, intelligent speech technology is also used in listening teaching, generating listening materials with different speeds and accents, or realizing speech-to-text conversion in classroom interactions to facilitate students in organizing their thoughts. However, the current application of the technology is still in the preliminary stage. The speech recognition error for voices with dialect accents is relatively large, and the application scope is mostly concentrated on speech training, with less exploration in fields such as text analysis and writing guidance.

3.4. Unbalanced construction of teaching resources

Although information technology has promoted the accumulation of teaching resources, there is an obvious imbalance in resource construction. At the regional level, colleges and universities in the eastern region have more complete digital resource reserves and can obtain high-quality resources through inter-school and enterprise cooperation; local colleges and universities in the central and western regions, restricted by funds and technology, mostly rely on external free resources, and the resources have weak pertinence and timeliness. At the inter-school level, key colleges and universities have dedicated resource development teams and can create high-quality online courses and virtual simulation projects; ordinary colleges and universities, especially private ones, have limited investment, and teachers mostly collect scattered resources, making it difficult to form a systematic resource database. In addition, the resource sharing mechanism is not perfect. Some high-quality resources of colleges and universities are only open to the internal campus, and cross-regional and cross-school sharing is insufficient, further exacerbating the gap in resource allocation.

4. Application strategies of information technology in language and character teaching in colleges and universities

4.1. Deepening technology integration and going beyond one-way display of courseware

To break the application mode of one-way display of multimedia courseware, it is necessary to deeply integrate technology with the objectives, content, and methods of language and character teaching, and build interactive and generative teaching scenarios. In terms of courseware design, teachers can use tools such as Authorware and Prezi to add interactive elements to the courseware. For example, in text analysis courses, interactive links such as "drag-and-drop matching of text excerpts" and "opinion voting" can be set up. Students participate in classroom interactions through operations such as clicking and dragging, and teachers adjust the teaching content in real time according to the results of students' interactions [9]. In writing courses, the annotation function of the courseware can be used to allow students to directly annotate and revise the model essays in class[5]. Teachers select typical cases for display and comment in the whole class, transforming students from passive receivers to active participants.

In addition to optimizing courseware, it is also necessary to expand the dimensions of technology integration and apply multimedia technology in combination with other information technologies. For example, in literature appreciation courses, virtual reality (VR) technology can be introduced to build an immersive experience module of literary scenes. In the teaching of "A Dream of Red Mansions", students can be placed in the Grand View Garden to intuitively feel the connection between scenes and characters. In oral teaching, multimedia courseware can be combined with real-time video connections to invite off-campus experts or students from other colleges and universities to participate in discussions, breaking the limitations of time and space. The application of technology should be flexibly adapted to the course content and student characteristics, avoiding the use of technology for technology's sake, and ensuring that it serves the realization of teaching objectives.

4.2. Making flexible use of platform data to drive the optimization of teaching process

The learning behavior data of online teaching platforms is a key basis for optimizing the teaching process. Teachers need to establish a data-driven concept, master basic analysis methods, and apply data throughout the entire teaching process. In the pre-class preview stage, teachers can check students' preview progress and test accuracy through platform data to accurately identify knowledge weaknesses [10]. For example, in grammar courses, if the accuracy rate of "non-finite verbs" is low, the key points of the class will be explained and additional cases will be supplemented. For students who have not completed the preview, teachers can remind them through platform private messages or conduct a brief review in class to help them keep up with the progress. In the in-class teaching stage, real-time data from the platform can be used to adjust the teaching rhythm [11]. For example, the accuracy rate and answering time can be counted through interactive answering tools.

If the accuracy rate is low and the time taken is long, the teaching speed will be slowed down and the content will be explained again; otherwise, the teaching progress will be accelerated. After class, it is necessary to comprehensively evaluate students' learning status by combining data such as homework scores, submission time, and discussion board speeches. For example, if a student's homework is average but they are active in speaking and revise their work many times, guidance on learning methods can be provided; if a student's score is low and the submission is delayed, teachers should communicate with them in a timely manner and provide personalized tutoring. Long-term tracking of data can also help analyze the progress trend of students, providing references for the adjustment of subsequent teaching plans.

4.3. Introducing intelligent tools to expand language practice scenarios

Introducing intelligent tools in accordance with teaching needs can make up for the shortcomings of traditional teaching in real-time feedback and personalized training. In writing teaching, AI essay correction tools such as Grammarly and Juku Correction Network can be introduced to quickly identify grammatical errors and logical problems, provide revision suggestions, and score the structure and content richness of the essay. Students can obtain feedback and make revisions in real time, while teachers can focus on in-depth comments on the theme and cultural connotation, improving the efficiency and quality of correction. For example, in applied writing courses, students first use AI to correct the format and grammar of the survey report, and then teachers comment on the data analysis logic and the feasibility of the conclusion. In oral teaching, intelligent dialogue systems such as Microsoft Xiaoice and iFlytek can be introduced to simulate scenarios such as interviews and business negotiations. Students can have real-time conversations with virtual characters through voice, and the system provides feedback on the accuracy and fluency of pronunciation. Students can practice repeatedly in their spare time, and teachers can check the practice data through the background and provide targeted guidance in class. In cultural teaching, intelligent cultural knowledge database tools can be introduced, allowing students to inquire about cultural-related issues at any time. Teachers can use the tools to integrate resources and design exploration tasks, helping students improve their cultural literacy and independent learning ability [12].

4.4. Jointly building and sharing resources to promote balanced regional development

To solve the problem of unbalanced resources, it is necessary to establish a cross-regional and cross-school mechanism for joint construction and sharing of resources. Educational administrative departments can take the lead in building provincial or national resource-sharing platforms for language and character teaching in colleges and universities, integrating high-quality courses, digital teaching materials, case databases, and other resources, formulating unified classification standards and evaluation systems to facilitate teachers and students to search and use, and ensuring the quality of resources through user ratings.

Inter-school pairing cooperation should be promoted. Key colleges and universities should give full play to their advantages in resources and technology to assist local colleges and universities in developing characteristic resources. For example, resources such as local literature interpretation and dialect-Pu Tong Hua comparison can be created in combination with the regional culture of the central and western regions. Local colleges and universities provide regional cultural materials to enrich the content of resources. Cross-school resource development teams should be established, combining teachers and technical personnel from different colleges and universities to ensure the scientificity and practicality of resources.

Enterprise-university cooperation should be strongly encouraged to develop high-quality resources with the help of enterprises' technology and funds. For example, cooperation can be carried out to create virtual simulation language training projects and intelligent speech training systems. Enterprises can obtain benefits through resource promotion, forming a sustainable cycle of development, application, promotion, and re-development. At the same time, an incentive mechanism should be established, and the achievements of resource construction should be included in the indicators for teachers' professional title evaluation and teaching excellence selection, so as to stimulate the enthusiasm of colleges and universities and teachers to participate and promote the long-term development of resource sharing.

5. Conclusion

Information technology provides a broad space for the reform and development of language and character teaching in colleges and universities. Its application can not only enrich the forms of teaching content, stimulate students' learning initiative, and realize personalized and precise teaching but also promote the transformation of language and character teaching from the traditional mode to a digital and intelligent one. At present, colleges and universities have achieved certain results in the application of information technology in language and character teaching, but they still face problems such as insufficient technology integration, inadequate data application, and unbalanced resources. It is necessary to further release the value of information technology through strategies such as deepening technology integration, making flexible use of platform data, introducing intelligent tools, and jointly building and sharing resources.

Disclosure statement

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Research on the Developmental Characteristics of Career Values among Post-00s Higher Vocational Students in the New Era: An Empirical Analysis Based on Higher Vocational Colleges in Shenzhen

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Abstract

This study surveyed 528 post-00s students from three higher vocational colleges in Shenzhen using a revised "Career Values Questionnaire for Higher Vocational Students" and conducted statistical analysis with SPSS 26.0. The findings reveal that the career values of post-00s higher vocational students in Shenzhen exhibit characteristics of "enterprising pragmatism," with "personal skill development" and "salary and benefits" jointly constituting the core driving forces. In terms of career evaluation criteria, "corporate innovation atmosphere" and "fair competition mechanisms" significantly surpass traditional concepts in importance. Career orientation demonstrates a clear regional retention tendency and industry foresight, with "staying in Shenzhen and the Greater Bay Area for development" and "engaging in strategic emerging industries" emerging as mainstream choices. The study indicates that the regional innovation ecosystem significantly shapes career values, necessitating the establishment of a collaborative guidance system involving higher vocational institutions, the government, and enterprises.

Keywords

Career values; Higher vocational students; Influencing factors; Post-00s

Online publication: August 26, 2025

1. Introduction

With the accelerated pace of China's industrial upgrading, the quality of cultivating high-quality technical and skilled talent has garnered increasing attention. According to 2023 data from the Ministry of Education, the "post-00s" generation comprises over 90% of the total student population in higher vocational colleges nationwide. Their career values will directly impact the stability and quality of the future industrial talent force. As the core engine of the Guangdong-Hong Kong-Macao Greater Bay

Area, Shenzhen, with its unique innovation environment, industrial structure, and urban culture, provides an ideal sample for studying the career values of young people.

Current research on the career values of college students exhibits three main shortcomings. For instance, a tendency to treat college students as a homogeneous group, neglecting the specific characteristics of higher vocational students, a lack of in-depth analysis of the "post-00s" as a distinct generational cohort, insufficient attention paid to the shaping influence of regional cultural and economic contexts on value formation. To address these gaps, this study focuses on "post-00s" students in Shenzhen's higher vocational colleges, aiming to systematically examine: first, the structural characteristics of this group's career values; second, the influence of demographic variables on these values; and third, educational countermeasures based on the empirical findings.

2. Literature review and research framework

2.1. Theoretical evolution of career values

Research on career values originated with Super's theory of work values, which defined career values as the work-related goals pursued by individuals [1]. Subsequently, Elizur proposed a dichotomy between instrumental and affective values, while Schwartz expanded the research perspective through cultural value dimensions [2]. In domestic research, the three-dimensional model developed by Ling et al. has been the most influential, encompassing the factors of prestige, stability (welfare), and development [3]. These theoretical achievements provide an important measurement foundation for this study.

2.2. Group characteristics of "post-00s" higher vocational students

Existing research points to three distinctive characteristics of "post-00s" higher vocational students:

(1) Their cognitive style as "digital natives" leads to a high dependence on the internet for information acquisition and social interaction patterns [4];

(2) They exhibit a value orientation where pragmatism and idealism coexist; they care about material security but also value self-actualization [5];

(3) They show high sensitivity to the regional economic environment, with their career choices often closely linked to local industrial development [6].

2.3. Construction of the analytical framework

Based on the literature review, this study constructs an analytical framework comprising three dimensions: career value goals (integrating stability and development factors), career value evaluation criteria (emphasizing modern organizational characteristics), and career choice orientation (reflecting regional and contemporary influences). This framework retains the measurement strengths of classical theories while also accommodating the regional characteristics of Shenzhen and the group characteristics of the "post-00s" generation.

3. Research design

3.1. Research subjects and sampling procedure

This study employed a stratified random sampling method. Between October and December 2023, three higher vocational colleges in Shenzhen, each with distinct specializations (one excelling in electronic information, one focusing on intelligent manufacturing, and one characterized by modern service industries), were selected. Approximately 187 students were randomly selected from the second- and third-year "post-00s" students in each institution. A total of 560 questionnaires were distributed. After screening out invalid responses (e.g., incomplete or patterned answers), 528 valid questionnaires were obtained, yielding an effective response rate of 94.3%. The specific sample structure is presented in **Table 1**.

3.2. Research instrument and data processing strategy

This study utilized a self-developed "Career Values Questionnaire for Vocational College Students." The development process was as follows: Initially, based on Ling's scale framework and incorporating relevant scales from recent scholarly research [7–9], combined with interview results from 20 students and 8 corporate HR professionals, a pool of initial items was generated. This was followed by an expert review involving three specialists (CVI = 0.92) and a pilot test with 150 participants. Through item analysis and exploratory factor analysis, the final scale comprising 30 items was established.

The formal scale consists of three dimensions: Value Goals (10 items, $\alpha = 0.86$), Value Evaluation (10 items, $\alpha = 0.84$), and Value Orientation (10 items, $\alpha = 0.82$). The overall scale demonstrated a Cronbach's alpha coefficient of 0.90. Confirmatory factor analysis indicated satisfactory model fit ($\chi^2/df = 2.78$, CFI = 0.94, TLI = 0.92, RMSEA = 0.058).Data processing was performed using SPSS 26.0, primarily involving descriptive statistics, t-tests, and one-way analysis of variance, with the significance level set at $P < 0.05$.

Table 1. Distribution of demographic characteristics of the survey sample (n = 528)

Variable	Category	Frequency	Valid percentage (%)
Gender	Male	285	54.0
	Female	243	46.0
Place of origin	Shenzhen Hukou	122	23.1
	Guangdong Province (non-Shenzhen)	201	38.1
	Outside Guangdong Province	205	38.8
Family background	Parents with entrepreneurial experience	158	29.9
	Parents without entrepreneurial experience	370	70.1
Field of study	Electronic information	174	33.0
	Intelligent manufacturing	137	25.9
	Modern service industries	217	41.1

Table 2. Descriptive statistics and rankings for dimensions of career values (n = 528)

Dimension	Specific indicator	Mean (M)	Standard deviation (SD)	Rank
Career value goals	Personal skill development	4.68	0.62	1
	Salary and benefits	4.63	0.65	2
	Acquiring cutting-edge industry knowledge	4.59	0.66	3
	Work-life balance	4.38	0.76	4
	Job stability	4.12	0.83	5
	Contributing to society	3.96	0.86	6
Career value evaluation	Corporate innovation atmosphere	4.55	0.67	1
	Fair competition and promotion mechanisms	4.52	0.69	2
	Corporate development prospects	4.47	0.71	3
	Flat organizational structure	4.40	0.73	4
	Harmonious interpersonal relationships	4.22	0.78	5
Career value orientation	Staying in Shenzhen/GBA for development	4.28	0.80	1
	Engaging in strategic emerging industries	4.48	0.66	2
	Prioritizing leading technology companies	4.25	0.77	3
	Flexible employment/freelancing	3.81	0.94	4
	Entrepreneurship	3.65	1.03	5

4. Findings and analysis

4.1. Description of overall characteristics of career values

Descriptive statistics were conducted on the three dimensions of career values and their core indicators, with the results presented in **Table 2**. The data clearly reveals the "enterprising pragmatism" structure of the career values among Shenzhen's post-00s higher vocational students.

Regarding career value goals, a dual-core driven pattern of "development" and "security" is evident. "Personal skill development" (M = 4.68) and "Salary and benefits" (M = 4.63) ranked highest, with very close scores. This indicates that while they possess a strong willingness for self-investment and growth, they are also unequivocal in their pursuit of material returns, forming a rational and pragmatic mindset of "trading competence for remuneration." "Acquiring cutting-edge industry knowledge" (M = 4.59) follows closely, reflecting their awareness of and proactive adaptation to technological iteration. Although "Job stability" (M = 4.12) remains valued, its relatively lower ranking suggests that within Shenzhen's dynamic market, students' perception of "stability" has shifted from seeking "institutional shelter" to relying on "skill preservation" (keeping skills fresh and relevant).

In terms of career value evaluation, the demand for a positive "soft environment" and "procedural justice" is remarkably high. "Corporate innovation atmosphere" (M = 4.55) and "Fair competition and promotion mechanisms" (M = 4.52) emerged as the most important evaluation criteria, significantly surpassing traditional factors like "Harmonious interpersonal relationships" (M = 4.22). This profoundly indicates that Shenzhen's innovation culture has been internalized as a core benchmark in their career selection; they desire to work in a vibrant, rule-based environment where talent is valued.

For career value orientation, a clear regional affinity and industry insight are demonstrated. The intention to "Stay in Shenzhen and the Greater Bay Area for development" (M = 4.28) is clear, attracted by the powerful industrial clusters and the city's open character. Simultaneously, they show a significantly stronger preference for "Engaging in strategic emerging industries" (M = 4.48) compared to other sectors, which aligns closely with Shenzhen's "20+8" industrial policy direction, demonstrating the rationality and foresight in their career choices. A certain level of acceptance towards "Flexible employment/Freelancing" (M = 3.81) also reflects the trend of diversified employment forms in the digital economy era.

4.2. Examination of group differences in career values

To explore the influence of demographic variables, tests for significant differences were conducted. Regarding differences based on place of origin, one-way ANOVA revealed significant differences in "Entrepreneurship tendency" ($F = 8.15$, $P < 0.001$) and "Importance attached to Salary and benefits" ($F = 5.89$, $P < 0.01$). Post-hoc tests (LSD) found that students with Shenzhen household registration had a significantly higher entrepreneurship tendency than those from non-Shenzhen Guangdong ($P < 0.01$) and outside Guangdong ($P < 0.001$). Conversely, students from outside Guangdong placed significantly greater importance on "Salary and benefits" than those with Shenzhen household registration ($P < 0.05$), reflecting the initial economic pressure faced by these "new immigrants" to establish themselves in Shenzhen.

Concerning differences based on family background, independent samples t-tests found that students whose parents had entrepreneurial experience scored significantly higher on both "Entrepreneurship tendency" ($t = 5.42$, $P < 0.001$) and "Requirement for job autonomy" ($t = 3.78$, $P < 0.001$) compared to students whose parents lacked such experience. This strongly demonstrates the intergenerational transmission effect of family business culture and risk-taking spirit.

Regarding differences based on field of study, ANOVA indicated significant differences across majors in the "Importance attached to Corporate innovation atmosphere" ($F = 6.34$, $P < 0.01$) and "Acquiring cutting-edge industry knowledge" ($F = 7.88$, $P < 0.001$). Post-hoc tests showed that students majoring in electronic information scored significantly higher on both indicators than students in modern service industries and intelligent manufacturing majors ($P < 0.05$). This is closely related to the characteristics of Shenzhen's globally leading electronic information industry, known for its rapid technological iteration, indicating that the specific traits of the industry associated with a student's major precisely shape their values.

5. Conclusion

Through empirical analysis, this study systematically reveals the typical characteristics of the career values of Shenzhen's "post-00s" higher vocational students: they exhibit a dual structure of "enterprising pragmatism," emphasizing both skill enhancement and innovative development, while also focusing on remuneration and regional opportunities. This is concretely manifested in three major characteristics:

(1) Internalized Innovation: Translating the city spirit of Shenzhen into an inherent demand for innovative environments and fair mechanisms;

(2) Skill-based Orientation: Viewing personal skills as the fundamental guarantee for coping with market changes;

(3) Rational Settlement: Basing career choices on a clear understanding of industries and self-positioning. This value map is the result of the mutual construction of the regional environment, industrial characteristics, and individual strategy, holding significant implications for the cultivation of innovative talent.

Based on the research findings, the following policy recommendations are proposed.

(1) For higher vocational institutions:

(i) Establish a linkage mechanism integrating "major-industry-occupation," incorporating standards from strategic emerging industries like new-generation information technology and intelligent manufacturing into the curriculum system, and setting up cutting-edge technology workshops;

(ii) Implement classified guidance strategies: offer entrepreneurship practice courses for students with Shenzhen household registration, and strengthen vocational skill certification training for students from other regions;

(iii) Innovate quality education models: integrate the cultivation of innovative thinking into practical training, and establish a system for accumulating and converting "innovation credits";

(2) For government departments:

(i) Improve the graded support system for technical and skilled talents, providing three-year housing subsidies and social security subsidies for non-Shenzhen hukou graduates;

(ii) Establish an effectiveness evaluation mechanism for industry-education integration, offering tax incentives and project priority support to enterprises that participate deeply in school-enterprise cooperation;

(3) For enterprises:

(i) Promote innovation in management models by establishing flat organizational structures and project-based teams, and implementing transparent reward mechanisms based on contribution.

Deepen industry-education collaboration to jointly cultivate a talent development ecosystem through initiatives like a "dual-tutor" system involving technical experts and the sharing of R&D projects.

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Divergence and Convergence of Speech Education between China and the United States from the Perspective of University General Education

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Abstract

Marked disparities exist between China and the United States in both the connotation and extension of speech education. From the perspective of university general education, an in-depth examination of the origins of divergence, the variations in practice, and the pathways toward integration holds both theoretical and practical significance. The fundamental sources of divergence lie in distinct cultural genes, collectivism versus individualism; political traditions, literary remonstration versus civic debate; and educational philosophies, moral orientation versus pragmatism. These underlying contrasts have resulted in systematic differences across multiple dimensions, including educational philosophy and objectives, instructional content and models, and assessment systems and standards. By advancing the transition from skill transmission to literacy integration, pursuing a balance between moral emotion and rational argumentation, and constructing a process-oriented and multidimensional evaluation framework, this study explores an innovative developmental pathway grounded in cultural self-awareness and cross-cultural integration. The ultimate goal is to establish a speech education system that is both rooted in indigenous cultural spirit and oriented toward global vision and future development, thereby promoting the continuous innovation and reform of university general education.

Keywords

China-United States comparison; General education; Speech education; Rhetorical education

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1. Introduction

The intellectual genealogy of general education in China can be traced back to 1940, when the distinguished scholar Qian Mu first articulated the principle of "integrated intellectual cultivation" in his seminal essay *Reforming the University System*. Subsequently, Mei and Pan further elaborated this conception by proposing that “general knowledge should constitute the foundation, whereas specialized knowledge should serve as its extension in *Understanding the University* [1].” As the cornerstone of higher education, general education is entrusted with the mission of transcending the narrow orientation of vocational or technical training. Its primary purpose lies in the cultivation of students’ transferable intellectual competencies and the holistic development of moral and personal character. It seeks to “endow individuals with the essential knowledge, abilities, cognitive habits, convictions, and refinement indispensable to life, thereby nurturing the comprehensive growth of both emotion and intellect [2].” The Harvard University Report on *General Education in a Free Society* further delineates the objectives of general education as fostering students’ capacities for critical thought, effective communication, sound judgment, and value discernment. This classical definition firmly establishes communicative competence as a foundational pillar of general education.

Within the conceptual framework of university general education, the capacity for precise expression and effective oral communication has emerged as a core intellectual competence and a foundational literacy essential to the formation of contemporary college students. Speech education, in this regard, should not be reduced to a utilitarian course for improving linguistic performance or rhetorical fluency; rather, it constitutes a comprehensive pedagogical enterprise that exerts a formative influence on both the intellectual and affective dimensions of the individual, thereby facilitating the integrated development of mind and character [3]. The telos of such education lies not in the cultivation of “eloquent sophists,” but in the holistic nurturing of morally grounded and intellectually autonomous persons.

Despite its pedagogical and moral significance, existing scholarship on speech education remains predominantly confined to descriptive analyses of its historical evolution, disciplinary orientation, curricular design, and activity systems. From the standpoint of general education, systematic and theoretically informed comparative investigations into the paradigms of speech education in China and the United States, two paradigmatic contexts of educational philosophy and practice, remain notably underdeveloped. Against this backdrop, the present study endeavors to examine, through the lens of general education, the cultural and philosophical sources of divergence, the pragmatic variations in pedagogical practice, and the pathways of epistemic and institutional integration between Chinese and American models of speech education. The ultimate objective is to contribute theoretical insight and empirical reference for the innovation of general education and the advancement of talent cultivation in contemporary higher education.

2. The cultural and philosophical origins of divergence in Chinese and American speech education

As one of the “three instruments for the transmission of civilization”, speech embodies profound educational connotations and possesses an inherently pedagogical nature [4]. The differences between Chinese and American speech education are deeply rooted in their respective cultural genes, political traditions, and educational philosophies, which collectively constitute the fundamental origins of their divergence.

2.1. Cultural gene divergence: “Collectivism” and “individualism”

The divergent cultural genes of China and the United States constitute the fundamental origin of their differences in speech education. Rooted in the cultural ethos of collectivism, Chinese speech education traditionally discourages overtly confrontational or excessively individualistic expressions that challenge authority or emphasize personal distinction. Instead, it values implicitness, restraint, and rhetorical moderation, requiring speakers to take into account a wide array of contextual factors, such as collective interests, social harmony, and interpersonal relations. Speech, in this context, often assumes a socio-political function, serving to disseminate official policies or promote mainstream values, and thus tends to resemble a performative report or ritualized presentation rather than a forum for dialectical reasoning or logical confrontation. Emphasis is consequently placed on the creation of emotional resonance, aesthetic atmosphere, and communal harmony rather than on adversarial argumentation.

In contrast, American speech education, shaped by the cultural foundation of individualism, places a high premium on personal expression and self-realization. It encourages students to articulate their ideas courageously, directly, and with clarity; to defend their own positions; and to present their distinct perspectives and needs. The pedagogical objective is to empower students to become visible, heard, and acknowledged through active expression. Within this paradigm, speech is regarded as a fundamental competency for self-expression, social influence, and civic participation, an indispensable literacy for personal development and social mobility. It also serves as a crucial avenue for individuals to manifest their intellectual autonomy, rhetorical talent, and leadership capacity.

2.2. Divergent political traditions: "Literary remonstration" and "civic debate"

As a form of socio-discursive practice, speech is profoundly shaped by the political culture within which it operates. Under China's political tradition of "literary remonstration", speech functions as an elite-oriented art of persuasion exercised within a vertical power hierarchy, emphasizing the symbolic and cultural capital of language as well as its influence upon those in authority. This tradition endows speech with distinctive discursive characteristics. In terms of discursive subjectivity, speech has historically been intertwined with bureaucratic identity and classical scholarship rather than with the universal cultivation of civic literacy. In terms of rhetorical strategy, it places exceptional emphasis on literary elegance, implicitness, and authority. Consequently, the function of speech was largely confined to vertical communication within bureaucratic systems rather than horizontal deliberation among different social groups. This deep-seated structure persisted into modern times, leading speech education in China to focus primarily on emotional appeal, structural integrity, and the transmission of positive moral values.

By contrast, the American tradition of "civic debate" conceives of speech as a deliberative instrument for public participation, highlighting the rational force of argumentation and the persuasive efficacy of discourse. As a nation constituted through a social contract among immigrant communities, the very process of America's founding can be regarded as an extended act of public oratory and debate, a mechanism for reconciling diverse interests and constructing political consensus. Historically, American speech education has undergone four stages of evolution: inception, integration, sustained development, and adaptive transformation [5]. Throughout this trajectory, public speaking competence has consistently been regarded as an indispensable civic skill, one that enables citizens to participate actively in democratic processes, shape public opinion, and fulfill civic responsibilities.

2.3. Divergent educational philosophies: "Moral orientation" and "pragmatism"

The value orientations and pedagogical trajectories of speech education in China and the United States distinctly reflect two divergent philosophical foundations, moral orientation and pragmatism. The Chinese tradition of moral-oriented educational philosophy closely intertwines speech with moral cultivation and social edification, emphasizing the classical tenets that "speech is the voice of the mind" and "rhetoric must be grounded in sincerity." Within this framework, speech is conceived as fundamentally anchored in virtue, with its primary function residing in the expression and consolidation of moral values and collective emotions through normative, affectively charged discourse. Consequently, speech transcends mere knowledge transmission, information exchange, or technical performance, evolving instead into a distinctive method, practice, and paradigm of moral education.

By contrast, the American tradition of pragmatic educational philosophy foregrounds the instrumental and functional dimensions of speech, situating it within a framework centered on problem-solving and civic engagement. Speech is thus regarded as an effective means to address concrete issues, achieve personal aims, and facilitate social progress. This orientation renders American speech education highly application-driven, emphasizing practical outcomes and communicative efficacy. As a result, speech instruction in the United States remains closely attuned to real-life contexts, characterized by pronounced instrumental rationality and a problem-oriented ethos. The divergence in these philosophical foundations has led to systematic differences in the two nations' approaches to speech education, manifested in goal-setting, curricular content, pedagogical design, and evaluative frameworks.

In essence, Chinese speech education is rooted in collectivist culture, centralized political tradition, and moral-oriented pedagogy, thereby privileging emotional resonance, aesthetic expression, and the normative transmission of cultural values. While American speech education, emerging from individualist culture, democratic deliberative politics, and pragmatic educational goals, places greater emphasis on logical persuasion, critical reasoning, and individual empowerment.

3. Divergent practices in Chinese and American speech education

From the perspective of general education, the practices of speech education in China and the United States exhibit systematic differences across multiple dimensions, including educational philosophy and objectives, curricular content and instructional models, as well as assessment systems and evaluative standards.

3.1. Divergences in educational philosophy and objectives

Chinese speech education is characterized by an orientation that may be described as content-centered and society-oriented. In pedagogical practice, speech is conceived primarily as an effective vehicle for knowledge transmission and ideological education. The content of speech is required to adhere to certain norms of propriety, emphasizing the accurate reproduction and systematic presentation of predetermined ideas. Its overarching aim is to serve collective purposes such as value guidance, emotional mobilization, and model exemplification, reflecting a pronounced instrumental and socially adaptive orientation. Consequently, its direct connection to the cultivation of critical thinking and the formation of civic consciousness remains relatively weak. At the level of higher education, specialized courses in speech are not commonly offered. Within university curricula, there are neither dedicated programs in speech studies nor degree tracks directly associated with public speaking [6]. Speech competence is typically categorized as a specialized skill or extracurricular talent, rather than being integrated as a core literacy required for all students.

By contrast, the United States demonstrates a markedly different orientation. According to Morreale, the proportion of American universities requiring public speaking as a general education course increased from 50.2% in 2006 to 79.4% in 2016 [7]. Unlike China's emphasis on content conformity and collective alignment, American speech education is guided by the core principles of diversified development and individual empowerment, underscoring the cultivation of critical thinking, creativity, and leadership through speech activities. It conceives of speech as a central medium for expressing viewpoints, engaging in rational dialogue, and constructing consensus within the public sphere. The learning objectives in American speech education are both explicit and operationalizable: students are expected to design and deliver speeches effectively for diverse audiences and complex communicative contexts, while also engaging in active listening and constructive feedback. This goal design directly corresponds to the cultural emphasis on freedom of expression, rational critique, and democratic participation, thereby reflecting a strong competence-oriented and civic-educational dimension.

3.2. Divergences in instructional content and pedagogical models

In terms of curricular content, speech education in China primarily emphasizes the mastery of linguistic fundamentals and the cultivation of expressive techniques. Instruction focuses on areas such as speech manuscript writing, the use of kinesics and facial expression, and practice in commonly employed speech forms across specific contexts. However, the scope, depth, and systematic treatment of topics such as logical reasoning, audience analysis, and argumentative rebuttal remain limited and require further enhancement. In classroom practice, students' chosen speech topics tend to revolve around the interpretation of assigned themes or the promotion of mainstream social values, often featuring grand or morally edifying subject matter. Pedagogically, Chinese speech instruction typically integrates two dominant modes, theoretical lecturing and practical exercises, with the former occupying a substantially larger proportion of class time. Instruction often centers on teacher demonstrations or imitative study of canonical speeches, reflecting a teacher-centered orientation.

In contrast, contemporary American speech education, as documented in the Foundational Communication Course Survey Report, structures its curriculum around several major domains: informative speaking, persuasive speaking, speech anxiety management, audience analysis, critical thinking training, listening skill development, and language use [8]. The content of American speech education is thus characterized by a high degree of structuralization and systematization. Courses are typically organized into modular units based on speech types, such as persuasive, impromptu, and special-occasion speeches, and place strong emphasis on reasoning and argumentation. Students are expected to employ academic data, authoritative sources, and empirical evidence to avoid logical fallacies. As a fundamental communicative practice, speech has long been celebrated as "the most popular foundational course in American universities," a testament to its indispensable status within U.S. higher education [9,10]. Most class time is devoted to student-led presentations, peer evaluation, and real-time feedback from instructors.

3.3. Divergences in assessment systems and evaluation standards

In China, the assessment of speech education primarily relies on standardized scoring systems. With respect to content, evaluation focuses on the ideational depth, value correctness, and completeness of the speech manuscript. In terms of delivery, emphasis is placed on linguistic fluency and eloquence, clarity and accuracy of pronunciation, and the expressiveness of emotion and affect. In essence, while attention is given to the content of the speech, factors such as verbal fluency, stylistic grace, emotional appeal, and stage presence are also accorded substantial weight. Indeed, the meticulous assessment of logical coherence and evidential reliability may at times be subordinated to the more holistic evaluation of overall "impression" or "momentum." Consequently, public speaking in the Chinese context tends to resemble a performative display, emphasizing aesthetic and affective effects.

By contrast, evaluation standards in American speech education are more refined, transparent, and systematized, with a pronounced focus on process-oriented assessment that compels every student to engage in public expression. Regarding content, evaluators pay particular attention to the clarity of thesis formulation, logical rigor, adequacy and validity of evidence, and the coherence and clarity of structure. As for delivery, attention is given to communicative immediacy, natural and confident demeanor, and interactive engagement with the audience. The overall effectiveness of a speech is measured not by its formal beauty but by whether it successfully engages the audience and achieves its communicative purpose.

Broadly speaking, public speaking in the American context functions less as a "performance" and more as a dialogic act of communication. In simpler terms, Chinese speech education approximates an "inward-oriented expressive" model, emphasizing the proper, decorous, and aesthetically refined articulation of internal thoughts, emotions, or predetermined content. Its underlying logic centers on transmission, adaptation, and harmony. American speech education, by contrast, can be conceptualized as an "outward-oriented persuasive" model, aimed at training students to assertively project ideas outward, seeking to influence and persuade others. Its internal logic is grounded in argumentation, critique, and competition.

4. Pathways toward the covergence of Chinese and American speech education

The purpose of tracing and comparing the divergences between Chinese and American speech education is not to render a value judgment regarding their relative merits, but rather to explore, through the selective assimilation of their respective strengths, a path toward the innovative development of general education grounded in cultural self-awareness and cross-cultural integration. The practical realization of this integrative vision may be approached from the following three dimensions.

4.1. Advancing from "skill transmission" to "literacy integration"

At present, speech education in China remains, to a considerable extent, dominated by a skill-oriented pedagogical model. Instruction typically focuses on external performative techniques such as the standardization of pronunciation and intonation, the use of gestures and kinesics, and the formulaic structuring of speech manuscripts. While this model may enhance students' fluency and formal proficiency in the short term, it also risks attenuating the essential functions of speech as an embodiment of thought and a medium of value communication. In his Historical Study of Speech Education, Gray identified "rhetoric" as a recurring keyword in many of the most representative American studies on speech education [11]. This observation indicates that American speech education largely inherits the classical Western rhetorical tradition, conceptualizing speech as an integrative practice that unites reflection, argumentation, and communication. Inspired by this perspective, the key to integrating Chinese and American paradigms of speech education lies in a fundamental reorientation of its pedagogical focus, that is, shifting from skill transmission, which privileges external performance, to literacy integration, which aims at the holistic development of the individual. Essentially, this transition represents an evolution from instrumentalism to humanism in educational values.

In practical terms, this transformation necessitates the construction of a competence-centered curriculum and activity framework. Instruction should no longer be governed by mechanical drills, but should instead be designed around the cultivation of critical thinking, cross-cultural communication, and other key competencies. Within this framework, the objective of speech education transcends the mere completion of a successful performance; it aspires to cultivate students as reflective, expressive, and communicative agents, thereby restoring the humanistic and educative essence of speech education.

4.2. Striving for a balance between "moral emotion" and "rational argumentation"

Chinese speech education has been profoundly shaped by its traditional cultural heritage, particularly the Confucian emphasis on moral virtue and emotional resonance. Guided by this value orientation, it places strong emphasis on whether the content of a speech demonstrates moral rectitude, linguistic dignity, and emotional sincerity, as well as on its capacity to convey and reinforce ethical values. However, such a moral-emotional focus can sometimes lead to an overreliance on affective appeal at the expense of rational analysis. Although American speech education theoretically acknowledges the triadic rhetorical appeals of ethos, pathos, and logos, in modern pedagogical practice it accentuates the primacy of logical argumentation. Instruction places particular importance on constructing chains of reasoning, supporting claims with empirical data, and maintaining logical rigor in argument development. This rational and evidence-based orientation facilitates the cultivation of students' critical thinking and structured expression, yet an excessive emphasis on technical argumentation may also render speech styles overly detached or impersonal, thereby diminishing their emotional warmth and humanistic appeal.

An ideal model of speech education should thus strive for a dialectical unity and equilibrium between moral emotion and rational reasoning. On the one hand, it should nurture sincerity of attitude and appropriateness of emotional expression; on the other, it must systematically cultivate students' logical reasoning and evidential competence. Only through such an integrated pedagogical approach can moral and rational dimensions be organically unified within both educational philosophy and instructional practice. Within a speech education system grounded in the fusion of emotion and reason, students would develop not only moral sensibility and humanistic concern, but also critical reasoning and argumentative competence, thereby enabling their speech to embody both emotional appeal and intellectual persuasion, achieving the genuine unity of truth and sincerity.

4.3. Constructing a "process-oriented" and "multidimensional" evaluation system

Within the framework of general education, speech education should never remain at the level of abstract theorization; rather, it must be grounded in a specialized, professional, and scientifically informed system of curriculum evaluation. Looking toward the future, speech education requires the establishment of a comprehensive evaluation system centered on the principle of learning promotion, characterized by process orientation and multidimensional assessment.

Emphasis should be placed on process-oriented evaluation. The assessment should encompass the entire preparatory process of speechmaking, including topic selection, research, outline drafting, and practice, thereby guiding students to value the intellectual labor underlying their preparation. This approach encourages students to take risks and to embrace errors, shifting their focus from "How well did I perform in the end?" to "How did I prepare and improve step by step?"

A multidimensional evaluation system should also be introduced, manifesting in two interrelated aspects: the diversification of evaluators and the pluralization of evaluation criteria. The former calls for the deconstruction of the teacher's evaluative monopoly by incorporating peer assessment and self-assessment, and even inviting external experts or simulated audiences to provide feedback, thereby ensuring a more comprehensive and objective appraisal. The latter requires the abandonment of rigid scoring rubrics in favor of differentiated evaluation standards designed in accordance with various types of speeches and stage-specific learning objectives. In this way, evaluation ceases to serve merely as a judgment of outcomes and instead becomes a meaningful learning process that promotes capability growth and reflective learning. By constructing an integrated system of process-oriented and multidimensional evaluation, the assessment no longer privileges naturally gifted speakers but instead rewards those who progress through continuous reflection, practice, and refinement. This truly embodies the principle of learning through assessment, redirecting the evaluative focus toward the holistic development of students' comprehensive competencies.

In summary, the integration of Chinese and American models of speech education should be guided by literacy integration as the overarching pedagogical goal, the balance between moral emotion and rational reasoning as the core educational content, and a process-oriented and multidimensional evaluation framework as the structural foundation.

5. Conclusion

This study has systematically demonstrated the necessity and feasibility of constructing a speech education system within general education through the creative integration of Chinese and American pedagogical models. The defining features of this system lie in its integrative, practical, and developmental nature. It represents not merely an improvement in instructional methods but an elevation of educational philosophy, responding directly to the core competencies demanded by the new era. Looking toward the future, neither simplistic "borrowing without adaptation" nor self-enclosed traditionalism offers a viable path forward. The genuine solution resides in a form of integration grounded in cultural confidence. This entails a deep understanding of the philosophical foundations and operational logics of both traditions, while prioritizing indigenous distinctiveness and embracing diversity through mutual enrichment.

By creatively combining the Chinese strengths of value orientation and cultural continuity with the American emphases on rational argumentation and civic participation, it becomes possible to develop a new model of speech education within general education, one that is rooted in the soil of Chinese culture yet oriented toward global vision. Such an approach not only fulfills the intrinsic requirement of enhancing the quality of talent cultivation in higher education but also aligns with the imperative of the global era: to educate individuals who are articulate communicators, responsible citizens, and active contributors to intercultural dialogue and mutual understanding among civilizations.

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Research on the Application of 3D Digital Orthopedic Technology in the Internship Teaching of Orthopedic Traumatology of Zhuang Medicine

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Abstract

Objective: To observe the effect of 3D digital orthopedic technology in the internship teaching of Strong Medicine Orthopedics and Traumatology. *Methods:* 60 undergraduate intern doctors rotating in the Department of Bone, Joint and Spine of the Guang Xi International Zhuang Medicine Hospital Affiliated to Guangxi University of Chinese Medicine from January 2023 to April 2024 were selected as the study subjects, and they were randomly divided into the control group and the observation group, and the observation group was taught by the 3D digital orthopedic technology teaching mode, and the control group was taught by the traditional teaching mode, so as to observe the teaching effects of the two groups. *Results:* They were regularly assessed with theory test once a month, after the end of training, the observation group theory test scores, skills assessment scores were 90.40 ± 1.13, 89.73 ± 1.17; the control group theory test scores, skills assessment scores were 86.30 ± 1.09, 85.50 ± 1.28, the observation group was significantly higher than the control group, and the difference was statistically significant ($P < 0.05$). The effect evaluation scores of the observation group in improving clinical thinking ability, diagnostic and therapeutic discernment ability, anatomical comprehension ability, surgical operation ability and teaching satisfaction were higher than those of the control group, and the difference was statistically significant ($P < 0.05$). *Conclusion:* 3D digital orthopedic technology teaching model can improve the teaching effect of undergraduate internship in the orthopedic and traumatology sciences of Zhuang medicine.

Keywords

3D digital orthopedic technology; Orthopedics and Traumatology of Zhuang Medicine; Teaching undergraduate medical internships; Overall teaching effect

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1. Introduction

Zhuang medicine constitutes an integral component of traditional Chinese medicine [1]. Developed through the Zhuang people's prolonged experiences in daily life, production activities, and the struggle against disease, it possesses a distinctive theoretical framework and rich content within the tradition of Chinese medicine [2]. Currently, clinical teaching for undergraduate medical students in Zhuang medicine orthopedics remains predominantly textbook-based and case study-oriented, exhibiting significant limitations: students struggle to develop an intuitive understanding of orthopedic anatomy and three-dimensional spatial awareness, resulting in tedious learning and poor retention [3].

Given the extensive scope of orthopedic conditions and their deep interconnection with anatomical and biomechanical principles, which heavily rely on spatial reasoning, this poses a considerable challenge for trainee surgeons. Consequently, reforming orthopedic teaching is imperative, necessitating a shift towards more intuitive and hands-on practical training approaches [4]. Moreover, given the scarcity of human anatomical specimens in contemporary medical education, clinical teaching predominantly relies on anatomical atlases and models [5]. However, these alternative tools struggle to accurately and comprehensively depict local anatomical features of the human body, often leading to comprehension difficulties for medical students newly entering clinical practice and hindering their mastery of relevant knowledge [6,7]. Consequently, how to overcome this limitation in the practical teaching of Zhuang orthopedic trauma surgery and effectively enhance clinical teaching outcomes has become a critical issue requiring urgent resolution [8].

Modern orthopedic clinical teaching increasingly emphasizes clinical competence as its core focus [9]. However, the traditional model relies on a one-way transmission of knowledge through oral instruction, which not only leaves medical students feeling disengaged but also neglects the cultivation of their clinical practice and applied skills, resulting in suboptimal teaching quality [10]. Concurrently, the rapid advancement and development of modern orthopedic diagnostic and therapeutic techniques demand higher standards of comprehensive competence from practitioners. This further highlights the limitations and obsolescence of traditional teaching approaches, presenting a formidable pedagogical challenge [11]. The introduction of digital 3D orthopedic technology teaching models holds promise for overcoming the limitations of traditional instruction [12]. This technology first employs three-dimensional visualization models to provide students with intuitive anatomical understanding, addressing their spatial conceptualization challenges [13]. It then reinforces clinical practice and application skills through simulated surgical procedures. Ultimately, it stimulates learning enthusiasm while achieving efficient translation of theory into clinical practice [14]. In light of this, this study implemented 3D digital orthopedic technology teaching and conducted an empirical analysis of its effectiveness during Zhuang medicine orthopedic trauma internships, as reported below.

2. General information

2.1. Case grouping information

60 undergraduate medical interns rotating through the Department of Orthopedics and Spine Surgery at the International Zhuang Medicine Hospital Affiliated to Guangxi University of Chinese Medicine between January 2023 and April 2024 were selected as study subjects. The observation group comprised 30 individuals (13 males, 17 females) aged 20–24 years, with a mean age of 22.26 ± 1.05 years. The control group comprised 30 individuals (11 males, 19 females) aged 21–24 years, with a mean age of 22.23 ± 0.94 years. General characteristics showed no statistically significant differences between groups ($P > 0.05$), rendering them comparable.

2.2. Inclusion criteria

The inclusion criteria are as follows:

(1) Fifth-year undergraduate medical students undertaking clinical rotations in the Department of Orthopedics and Spinal Surgery at the International Zhuang Medicine Hospital affiliated with Guangxi University of Chinese Medicine;

(2) Voluntary participation in this study with consent to actively cooperate throughout the entire process.

2.3. Exclusion and dropout criteria

The exclusion criteria are as follows:

(1) Voluntary withdrawal during the study period;
(2) Inability to continue participation due to sick leave or personal leave during the study period.

2.4. Methodology

All subjects utilized standardized teaching materials: the third edition of Zhuang Medicine Traumatology (People's Medical Publishing House, five-year program) and Practical Standards and Clinical Applications of Zhuang Medicine External Treatment Techniques served as primary references for lesson preparation and delivery. Senior professors with extensive clinical and teaching experience in Zhuang orthopedic traumatology conducted guided lectures. Theoretical instruction occurred weekly, comprising two teaching periods (80 minutes) per session, with assessments conducted at the conclusion of each three-week rotation cycle.

2.4.1. Observation group

The observation group employed a 3D digital orthopedic technology teaching model. Specific implementation steps are detailed in **Table 1**.

2.4.2. Control group

The control group employed the traditional clinical teaching model. Specific implementation steps were as follows:

(1) Upon entering the department at the start of each rotation cycle, teaching staff distributed relevant materials, including the Traditional Clinical Pathway Chart for Zhuang Medicine Traumatology and radiological documentation to trainee doctors;
(2) Clarified the teaching syllabus and objectives for Zhuang Medicine Traumatology, requiring trainees to study and master key aspects, including pulse diagnosis, visual diagnosis, clinical manifestations, Zhuang medical diagnosis, traditional Chinese medical diagnosis, Western medical diagnosis, and treatment

Table 1. Clinical teaching pathway chart for 3D digital orthopedic technology in Zhuang Medicine Traumatology

Teaching phase	Lecture time	Lecture content	Lecture format
Preparation before class	10 min	Prior to the lecture, the instructor distributed 3D-printed models and radiographic materials related to Zhuang orthopedic trauma cases, all sourced from authentic hospitalized patients. Each group member prepared relevant theoretical knowledge and teaching materials pertaining to Zhuang orthopedic trauma science	3D printed model
Teaching process	60 min	Clarify the teaching objectives of Zhuang Medicine Orthopedics. Group members shall analyze and present clinical cases through consultation, pulse diagnosis, visual examination, and physical assessment, supplemented by 3D-printed models. The instructor shall conduct a comprehensive evaluation of students' prepared teaching materials and discussion participation, gaining real-time insight into their mastery of relevant knowledge. Emphasis shall be placed on the practical and applied nature of Zhuang Medicine Orthopedic theory	Group discussions, 3D printed models, short videos, PowerPoint presentations, chalkboard notes
In-class assessment	10 min	In-class assessments evaluate learners' mastery of relevant knowledge and gauge satisfaction levels	Classroom tests, questionnaires
Lesson summary	10 min	The instructor summarized the presentations from each study group, providing timely feedback to rectify misconceptions arising during instruction. Detailed explanations were supplemented with 3D printed models, while mind maps were employed to organize the course's knowledge framework and highlight key points. Finally, group members were guided to develop sound clinical reasoning skills and conduct summaries, significantly enhancing trainees' interest in and practical abilities within the clinical study of Zhuang orthopedic trauma science	PowerPoint presentations, chalkboard notes, mind maps

protocols for disease patterns where Zhuang medicine holds comparative advantages;

(3) During teaching sessions, trainees independently collected patient medical histories and conducted physical examinations, followed by group discussion, analysis, and summarization;

(4) Finally, the instructor summarized each learning group's presentation, provided corresponding feedback, and corrected misconceptions arising during the teaching process.

2.5. Observation indicators

2.5.1. Theoretical assessment

All teaching staff comprised associate professors or above from the Department of Orthopedics and Spinal Surgery at the Affiliated International Zhuang Medicine Hospital of Guangxi University of Chinese Medicine. Examinations were uniformly set with identical content and timing. Interns enrolled in this study underwent closed-book written examinations, scored out of 100 points, primarily assessing their mastery of theoretical knowledge in Zhuang orthopedic trauma medicine.

2.5.2. Practical assessment

Assessments of teaching staff shall be conducted by associate professors or higher-ranking personnel from the Department of Orthopedics and Spinal Surgery at the Affiliated International Zhuang Medicine Hospital of Guangxi University of Chinese Medicine. Examinations shall be held at the same time each rotation week. Each learning group shall randomly select one in-hospital case to evaluate trainees' practical skills through assessment of medical history taking, physical examination, radiographic interpretation, differential diagnosis, anatomical understanding, and treatment planning. A practical assessment score shall then be determined, with a maximum of 100 points.

2.6. Teaching outcomes

Upon completion of both clinical rotation cycles, instructors uniformly distributed two-way evaluation questionnaires to assess students' perceptions of teaching effectiveness across clinical reasoning, diagnostic analysis, anatomical comprehension, and surgical proficiency, each rated on a 10-point scale. Questionnaire analysis assessed student satisfaction with the course, categorized into five responses: strongly agree, agree, neither agree nor disagree, disagree, and strongly disagree. A total of 60 questionnaires were distributed, achieving a 100% return rate.

2.7. Statistical methods

Data were statistically analyzed using SPSS 26.0 statistical software. Quantitative data are expressed as mean ± standard deviation (SD) with intergroup comparisons conducted via t-tests. Qualitative data are denoted by n, with comparisons performed using χ^2 tests. Differences were considered statistically significant at $P < 0.05$.

3. Results

3.1. Comparison of theoretical and practical scores between the two groups of interns

Following completion of the rotational training program, both theoretical and practical scores were significantly higher in the observation group than in the control group ($P < 0.05$), as shown in **Table 2**.

Table 2. Results of theoretical and practical examinations for two groups of interns (%)

Group	Theoretical results	Practical results
Observation group (n = 30)	90.40 ± 1.13	89.73 ± 1.17
Control group (n = 30)	86.30 ± 1.09	85.50 ± 1.28
t	14.302	13.359
P	0.000	0.000

3.2. Comparative questionnaire survey on teaching methods among two groups of interns

Following completion of the two internship rotations, trainees in the observation group achieved statistically significantly higher scores than the control group in teaching effectiveness evaluations concerning clinical reasoning ability, diagnostic and therapeutic discernment, anatomical comprehension, and surgical proficiency ($P < 0.05$), as shown in **Table 3**.

Table 3. Survey results on teaching methods from two groups of interns (%)

Group	Clinical reasoning skills	Diagnostic and therapeutic reasoning ability	Anatomical comprehension	Surgical proficiency
Observation group (n = 30)	8.0 ± 0.74	7.83 ± 0.53	8.03 ± 0.56	7.80 ± 0.61
Control group (n = 30)	7.10 ± 0.61	7.40 ± 0.56	7.13 ± 0.63	6.60 ± 0.56
t	5.137	3.067	5.873	7.915
P	0.000	0.003	0.000	0.000

Table 4. Two sets of teaching satisfaction results (%)

Group	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
Observation group (n = 30)	4 (13.3%)	8 (26.7%)	10 (33.3%)	5 (16.7%)	3 (10%)
Control group (n = 30)	0 (0.0%)	2 (6.7%)	5 (16.7%)	13 (43.3%)	10 (33.3%)
χ^2			16.591		
P			0.002		

3.3. Comparison of teaching satisfaction outcomes between two groups of interns

Following completion of the rotational training program, teaching satisfaction survey results indicated that interns in the observation group, who underwent instruction using the 3D digital orthopaedic technology teaching model, demonstrated significantly higher satisfaction levels than those in the control group. This difference was statistically significant ($P < 0.05$), as shown in **Table 4**.

4. Discussion

As a significant branch of traditional Chinese medicine, Zhuang medicine has been present since ancient times, as the recognition of human anatomy is fundamental to understanding disease mechanisms. Historical records indicate that the Five Viscera Diagram by Ou, produced in the Lingnan Zhuang region during the Northern Song Dynasty, represents China's earliest extant illustrated anatomical atlas with textual annotations [15]. This work provides remarkably detailed depictions of the structures of the internal organs and their local anatomical characteristics. Furthermore, during the anatomical process, it observes and expounds upon the related etiological and patho-mechanical changes from a medical perspective [16]. This fully demonstrates the long-standing tradition within Zhuang medicine of emphasizing morphological foundations.

In summary, the challenges in achieving effective teaching outcomes in Zhuang medicine trauma surgery primarily stem from the abstract nature of its theoretical framework and the scarcity of high-quality anatomical materials in instruction. The latter has led to an overreliance on anatomical atlases and conventional models, which failed to convey critical anatomical and pathological information in an intuitive and comprehensive manner, thereby limiting students' development of both theoretical knowledge and practical skills [17]. In light of this, 3D-printed models capable of precisely replicating human anatomical details offer a novel approach to resolving these issues, making their exploration and application particularly imperative [18].

Existing research confirms that the selection of clinical teaching methods in orthopedics directly determines medical students' depth of theoretical knowledge and level of practical skills [19]. The emergence of 3D digital orthopedic technology offers novel approaches to reforming orthopedic education [20]. By transforming complex anatomical structures and surgical procedures into visualized, digital, intelligent and interactive models, this technology significantly reduces students' cognitive load. Compared to traditional anatomy reliance on scarce specimens, 3D models offer convenient acquisition, reusability, and dynamic presentation of pathological features, thereby greatly stimulating students' learning initiative and immersion [21].

Research indicates that this technology demonstrates significant advantages in enhancing the teaching effectiveness and quality of orthopedic trauma training for resident trainees [22]. Moreover, the deep integration of 3D digital orthopedic technology with modern teaching methodologies such as problem-based learning (PBL) and case-based teaching is pivotal to enhancing the quality of clinical internship instruction [23]. In this process, the core role of clinical educators should evolve from knowledge disseminators to learning facilitators and resource designers. By meticulously crafting teaching cases based on 3D models, educators can fully leverage the technology's instructional potential to dynamically expand and enrich the teaching content of Zhuang medicine trauma science. This student-centered, interactive learning environment effectively stimulates curiosity and autonomy, thereby fundamentally improving teaching efficiency and quality.

This study confirms that the observation group employing the 3D digital orthopedic technology teaching model demonstrated significantly superior educational outcomes across all dimensions compared to the traditional teaching model control group ($P < 0.05$). The success of this model lies in its ability to stimulate trainee doctors' proactive learning interest through a visualized and interactive learning environment and, subsequently, deepen their understanding of theoretical knowledge by providing intuitive representations of pathological anatomical relationships. Ultimately, building upon this foundation, this systematically cultivates and enhances their core competencies in clinical reasoning, diagnostic analysis, and surgical techniques. This study demonstrates that the model not only enhances the precision and efficacy of teaching but also provides educators with a powerful tool for pedagogical refinement, possessing significant potential for wider implementation.

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Disclosure statement

The authors declare no conflict of interest.

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Vibe Learning: Cultivating Mathematical Modelling Literacy in High School: A Quasi-Experimental Mixed-Methods Study

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Abstract

Vibe learning brings the idea-first ethos of vibe programming into classroom practice: learners set intentions and evaluation criteria while technology recedes. We report a quasi-experimental mixed-methods study in two parallel Grade 11 classes: an experimental class used an AI-augmented modelling sandbox with a Socratic micro-tutor across three scenarios, while a control class received traditional instruction. Data included baseline questionnaires, platform logs, post-task micro-surveys, and summative assessments. Vibe learning enabled full-cycle modelling within regular periods: completion time fell by 33%, first-attempt correctness rose, submission cycles dropped, and feedback latency shrank from minutes to seconds. Both classes reached similar concept mastery by end of the term, with larger self-efficacy gains in the experimental group. We outlined orchestration to balance efficiency with productive struggle and situate the design in pragmatism, social constructivism, phenomenology, hermeneutics, and virtue epistemology, showing a scalable, human-centered path to modelling literacy with transparent, computable evidence.

Keywords

AI tutor; Mathematical modelling literacy; Vibe learning

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1. Introduction

Mathematical modelling literacy, problem framing, model construction, analysis, validation, and contextual decision making is essential yet difficult to enact within ordinary lessons. Time pressure, delayed feedback, and uneven process visibility often compress modelling into procedural exercises [1]. We present vibe learning, a design where human ideas lead and technology recedes. The teacher and students co-formulate intentions and criteria; a lightweight sandbox and Socratic AI micro-tutor support exploration, verification, and traceable revision.

Building on a school-built atmospheric learning platform, the research questions are as follows:

(1) Does vibe learning improve process efficiency and accuracy in modelling tasks?

(2) How does it affect learning outcomes and self-efficacy relative to traditional instruction?

(3) What trade-offs arise for cognitive load, initiative, and sense of accomplishment?

The contributions of this study are as listed:

(1) A classroom-tested vibe learning work flow with a minimal evidence chain (original → AI feedback → resubmission → teacher review);

(2) Empirical results from a quasi-experiment with mixed methods in authentic lessons;

(3) A philosophical account clarifying why and how idea-first, human-centered orchestration can coexist with powerful AI scaffolds.

2. Vibe learning framework

Vibe learning comprises three continuous stages:

(1) Vibe ideation (ideas first): From an authentic situation, learners clarify goals, variables, constraints, boundary conditions, and acceptance criteria without fixing a method in advance [2];

(2) Vibe programming (rapid prototyping): Natural-language specifications are translated into classroom-ready sandboxes (web apps) with AI assistance. Technical details stay invisible; learning mechanics and evaluation remain explicit [3];

(3) Vibe learning (implementation): Students plan first, then interact with the sandbox for parameter probing, sensitivity checks, and validation. A Socratic micro-tutor gives just-in-time hints and epistemic prompts (no answers). All attempts and revisions are logged as a minimal evidence chain to support formative assessment and reflection [4].

3. Methodology

3.1. Participants and setting

Two intact Grade 11 classes in a public model high school (Shanghai) participated (n = 80; experimental class, n = 40; control class, n = 40). The same teacher taught both classes; devices were available in the experimental class. Permissions and ethics approvals were secured [5].

3.2. Instruments and data sources

Baseline questionnaire was used to investigate demographics, prior exposure to modelling and AI tools, and a 13-item modelling self-efficacy scale (problem analysis, model construction, tool use, validation, communication; 1–5 Likert) [6]. Platform logs (experimental class) were also employed for timestamped actions (parameter edits, submissions), AI interactions, automated correctness checks, and derived metrics such as time-on-task, submission cycles, first-attempt correctness, and feedback latency [7]. Post-task micro-surveys were utilized to assess cognitive load (7-point mental effort), engagement and perceived usefulness. Finally, summative assessments, which are a paper-based modelling test (novel scenario, no AI) and a short concept inventory were used.

3.3. Intervention tasks and control condition

The intervention tasks for experimental classes and conditions for control classes are as outlined below:

(1) Quadratic inequality:

(i) Experimental class: Express constraints from a textual context as a quadratic inequality; visualize solution sets; verify with representative points;

(ii) Control class: parallel content on paper with teacher checks [8,9];

(2) Walking in the rain:

(i) Experimental class: Model total rain exposure as a function of speed (with wind); explore for optimal speed; test extremes and limitations;

(ii) Control class: algebraic reasoning and hand-drawn graphs [10];

(3) Financial option valuation:

(i) Experimental class: Parameterize a European call stylized model; explore sensitivity (e.g., volatility); validate reasonableness via edge cases;

(ii) Control class: lecture plus worksheet practice [11].

In all experimental classes, students first plan without hints (*"human brain first"*), then use the sandbox while control classes used conventional explanation, board work, and paper tasks [12].

3.4. Design and analysis

A quasi-experimental design compared classes on process and outcome measures. Descriptive statistics summarized effects; inferential tests guided interpretation where distributional assumptions held. Interviews (sampled students) and observations provided qualitative context via thematic analysis [13].

4. Results

4.1. Baseline equivalence

Both classes were comparable at baseline (gender balance, recent math performance, prior exposure to modelling and AI tools) (**Table 1**).

Table 1. Baseline background (experimental vs. control, n = 80)

Characteristic	Experimental	Control
Avg. math percentile (%)	50	52
Modelling exposure: none/ occasional/systematic (%)	48/45/7	50/40/10
AI tools: never/occasional/regular (%)	60/35/5	55/40/5

4.2. Process efficiency and accuracy

Across tasks, the experimental class was faster and more accurate, with fewer cycles and markedly shorter feedback loops [14] (**Table 2**).

Table 2. Process and performance metrics (task averages)

Metric	Experimental	Control
Completion time (relative)	≈ -30%	Baseline
Advanced task time (T3)	≈ -50%	Baseline
First-attempt correctness	≈ 65%	≈ 40%
Final success rate	≈ 95%	≈ 70%
Submission cycles (median)	3	≈ 5

4.3. Learning outcomes and self-efficacy

Both classes achieved strong end-of-term modelling performance on a novel paper task (no AI). The experimental class showed a higher mean (trend) and larger self-efficacy gains [15].

4.4. Cognitive load and perceptions

Control students reported higher mental effort (~ +1.0 to +1.2 on a 7-point scale) and more time awaiting teacher feedback (**Table 3**). Students of experimental classes praised immediacy and reduced frustration; a minority expressed concern about over-relying on hints and welcomed structured "think-first" windows [16].

Table 3. Selected pre-post measures

Measure	Experimental		Control	
	Pre	Post	Pre	Post
Modelling self-efficacy (1–5)	2.6	3.8	2.5	3.5
Modelling test (0–100)	55	85	56	79
Concept inventory (0–20)	-	16.5	-	16.2

5. Discussion

5.1. Advantages of vibe learning

Vibe learning offers several advantages as follows:

(1) Feasible full-cycle modelling: Near-real-time guidance makes open-ended tasks executable within a single period, including advanced content typically deferred [17];

(2) Computable formative evidence: The minimal evidence chain supports granular feedback, targeted re-teaching, and reflective debriefs; teachers gain visibility into process, not just product;

(3) Comparability and reuse: Uniform sandboxes standardize affordances across classes, enabling cross-cohort comparison and iterative improvement [18].

5.2. Tensions and orchestration

Faster convergence and higher first-try accuracy can reduce trial diversity and perseverance opportunities. Hence, we recommend a phased choreography:

(1) Sense-making first (no hints, timed): Representations, assumptions, plan [19];

(2) Targeted prompts to nudge strategy (not supply steps);
(3) Verification-without-answers: Tools confirm/falsify; students explain discrepancies [20];
(4) Meta-reflection: A short "what changed my mind" note. Lower extraneous load increases throughput but may blunt the "earned" feeling [21];
(5) Preserve productive difficulty with delayed hints and epistemic questions (e.g., "What would count as evidence against your model?").

5.3. Philosophical grounding

Pragmatism frames modelling as disciplined inquiry: hypothesize, intervene (simulate), observe consequences, revise. The sandbox is a laboratory for warranted assertions rather than answer-getting [22].

Social constructivism situates knowledge in mediated dialogue among teacher, peers, and AI; the micro-tutor functions as a mediator, not an oracle, to maintain learner agency [23]. Phenomenology opens problem-worlds (rain, traffic, markets) so structures-to-be-mathematized become present-to-experience [24]. Hermeneutics underscores iterative interpretation across symbol and context; students loop between formalism and narrative, refining meaning [25]. Virtue epistemology and phronesis (practical wisdom) guide when not to help: cultivate curiosity, perseverance, and intellectual humility through designed, bounded struggle [26].

6. Limitations and ethics

This single-site quasi-experiment used intact classes and a single instructor; broader generalization requires multi-site replication. Some measures (e.g., self-efficacy) rely on self-report. Data were minimized, anonymized, and locally archived; the classrooms used emphasized transparent disclosure of AI roles and assistance [27].

7. Conclusion

Vibe learning operationalizes idea-first, evidence-rich pedagogy for modelling. In authentic lessons, it delivered faster, more accurate task completion with lower cognitive burden, while maintaining end-of-term concept mastery and boosting self-efficacy. To avoid eroding independence, orchestration should protect human sense-making before assistance and require reflective justification after it. As schools seek scalable paths to modelling literacy, vibe learning offers a human-centered design where technology supports, but does not eclipse judgment.

Disclosure statement

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Exploration and Reform of Signals and Systems Course Construction for Cultivating Engineering Application Capabilities

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Abstract

The signals and systems course is a core component of the electronic information science and technology major, characterized by its strong theoretical foundation and abstract concepts. Under traditional teaching models, students often struggle to establish concrete connections between mathematical derivations and engineering applications. To address this issue, this paper proposes utilizing a self-tracking antenna system, a typical engineering system, as a consistent engineering teaching example throughout the course. It integrates the core theoretical knowledge of “signals and systems” into the analysis, modeling, and simulation practices of this example. By reconstructing a theory-case-practice integrated curriculum, designing blended learning-based teaching activities, and deeply excavating and integrating ideological and political elements, a new teaching model centered on cultivating engineering application capabilities and shaping values has been constructed. Teaching practice indicates that this reform significantly enhances students’ learning interests, engineering practical abilities, and comprehensive qualities in solving complex engineering problems, providing a valuable reference for cultivating high-quality talents adapted to modern communication technology development.

Keywords

Curriculum ideology and politics; Engineering case studies; Self-tracking antenna; Signals and systems

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1. Introduction

Signals and systems is an indispensable core professional foundational course for the electronic information science and technology major, serving as a bridge between preceding and subsequent courses. Its primary objective is to cultivate students’ abilities to analyze and process signals using mathematical tools, as well as understand and design systems. It also lays a crucial foundation for subsequent courses such as digital signal processing, communication principles, automatic control principles, and radar principles. The course's characteristics, including numerous mathematical formulas and abstract physical concepts, often render students' learning experiences dull and challenging, making it difficult for them to grasp the ultimate purposes and practical values of various transformations and analyses.

Traditional teaching models commonly exhibit a triple emphasis on mathematical derivations while neglecting physical concepts, isolated knowledge points over systematic associations, and theoretical problem-solving over engineering applications. This leaves students in a state of confusion, unable to establish effective knowledge transfer channels or connect classroom learning with future engineering applications and professional development, thereby largely severing the close link between theory and engineering applications and hindering the cultivation of students' engineering application capabilities. It also fails to effectively meet the requirements for cultivating complex engineering problem-solving abilities outlined in engineering education professional accreditation standards [1].

With the in-depth advancement of the new engineering initiative, the demand for cultivating high-quality talents capable of solving complex engineering problems in higher education institutions continues to rise [2,3]. To address the aforementioned teaching challenges, it is essential to introduce comprehensive engineering case studies that can permeate the core knowledge of the course, enabling students to perceive the practical value of theory in solving engineering problems while learning.

This paper employs a self-tracking antenna system as a consistent engineering case study throughout the signals and systems course. Widely applied in satellite communication, radar, and radio astronomy, this system operates by ensuring the antenna's main beam precisely aligns with a moving target in real-time to guarantee high-quality signal reception or transmission [4–6]. It encompasses the complete processes of signal generation, transformation, processing, transmission, and system feedback control, covering signal modulation and demodulation, filtering, system modeling, feedback, and stability analysis [7,8]. The entire tracking loop fully embodies the knowledge of the "signals and systems" course, serving as a concrete manifestation of its content.

2. Curriculum design

2.1. Overall teaching design

Centered around the self-tracking antenna system engineering case study, this paper constructs a theory-case-practice integrated teaching system, streamlining and optimizing the content of the signals and systems course. It breaks away from the traditional mode of isolated chapter-based knowledge explanation, forming three intertwined and parallel teaching mainlines: the theoretical line, the case line, and the practical line, achieving a deep fusion of knowledge transmission and engineering capability cultivation.

The theoretical line aims to concisely explain core concepts, systematically covering the key knowledge of signals and systems to ensure a complete knowledge system and lay a solid foundation for subsequent learning. Following modern educational structural principles, the teaching content is divided into two major sections: signal analysis and system analysis.

The signal analysis section focuses on the time-domain and frequency-domain characteristics of continuous and discrete-time signals, such as convolution operations and Fourier transforms, assisting students in clarifying signal representations and conversions in different domains through formula derivations and graphical demonstrations. The system analysis section delves into the time-domain and frequency-domain responses and stability of linear time-invariant systems, combining practical models like low-pass and high-pass filters to elucidate system input-output characteristics, enabling students to grasp analytical methods and techniques. Simultaneously, attention is paid to the internal connections and logical progressions among knowledge points, guiding students to construct knowledge frameworks and cultivate holistic comprehension abilities.

The case line utilizes the self-tracking antenna system as a carrier, dissecting it into antenna reception, signal processing, and control execution subsystems, and precisely aligning them with theoretical knowledge to correspond abstract theories with specific engineering scenarios, aiding students in understanding the practical application value of theories. When explaining signal analysis, the spatial electromagnetic wave signals received by the antenna subsystem are used as examples to analyze their time-domain waveforms and frequency-domain characteristics, allowing students to perceive the complexity and diversity of actual signals. In the system analysis section, the filter design of the signal processing subsystem is employed to explain how to select types, determine parameters, and analyze processing effects based on performance requirements. By aligning each subsystem of the self-tracking antenna system with the theoretical knowledge points of the course, a correspondence relationship between theory and practice after case integration is formed, as shown in **Table 1**, enabling students to deeply recognize the importance of theoretical knowledge in solving practical engineering problems and enhancing their abilities to analyze and solve practical problems using theoretical knowledge.

The practical line employs MATLAB simulation verification as a platform, utilizing MATLAB/Simulink to construct a simplified simulation model of an antenna angle automatic tracking system. By altering parameters such as signal frequency, filter bandwidth, and system gain, students can observe changes in time-domain tracking curves and frequency-domain spectra, intuitively understanding the guiding role of theory in system performance. Through experiments like setting excessively high gains to induce system oscillations, students deepen their understanding of stability concepts.

Through the intertwined and parallel teaching design of the theoretical line, case line, and practical line, the knowledge of the signals and systems course is no longer confined to mathematical formulas and concepts but transformed into tools capable of solving practical engineering problems, effectively achieving the teaching objective of cultivating students' engineering application capabilities.

2.2. Curriculum-based ideological and political education design

Curriculum-based ideological and political education is an important part of students' course learning. In the teaching of signals and systems, it is essential to deeply explore the ideological and political elements embedded within the course content, integrating the cultivation of abilities to solve complex engineering problems into the entire process of knowledge transmission and skill development,

Table 1. Correspondence between theory and practice after case integration

Course chapter	Theoretical knowledge points	Corresponding points in self-tracking antenna case	Teaching form suggestions
Overview of signals and systems	Continuous-time signal/discrete-time signal, energy signal/power signal	RF signal received by the antenna (continuous), and digital signal after sampling (discrete)	Class summary
Time-domain system analysis	Convolution, system properties (linearity, time-invariance)	Step response of a servo system	Classroom explanation + post-class reflection questions
Fourier series and transform	Frequency spectrum principles, modulation/ demodulation	Spectrum of sum/difference signals, spectral shifting in coherent demodulation	Lecture breakdown with MATLAB-based visualization of spectrum dynamics
Laplace transform	Transfer function of a system, zero-pole representation, stability criteria	Establish an S-domain model for servo systems, analyze transfer functions of the motor and controller, and discuss the impact of pole locations on stability	Symposium & group project
Z-transform	Discrete-time system	In modern digital tracking receivers, after ADC sampling, error signal processing and control algorithms are implemented in the digital domain (DSP/FPGA)	Extended introduction
System frequency domain analysis)	Frequency response, filter	Design of intermediate frequency (IF) filter in receivers, drawing and analysis of open-loop bode plot for servo Systems, with stability and dynamic performance evaluation	Detailed analysis of key cases, simulation experiments

so as to achieve an organic fusion of ideological-political education and professional teaching [9,10].

By combining relevant theoretical knowledge of self-tracking antenna systems, we can mine the underlying principles of Marxist philosophy and guide students to establish a scientific worldview and methodology. When explaining time-domain and frequency-domain analyses of signals, we should clarify that time-domain waveforms represent the phenomena of signal variations, while frequency-domain features reflect the essential attributes of signals, helping students understand the dialectical relationship between phenomena and essence. When analyzing the bandwidth design of loop filters, by comparing the engineering contradictions between noise suppression and dynamic response speed, we can guide students to apply the thinking of focusing on major contradictions to solve practical problems.

Based on the engineering application scenarios of self-tracking antenna systems and in combination with China's achievements in aerospace technology development, we can stimulate students' patriotic enthusiasm and sense of mission. When introducing China's Beidou Navigation Satellite System in the course, we can tell the stories of how researchers overcame technological blockades through perseverance and independent innovation, enabling students to directly perceive the development strength of China's aerospace technology. Considering the current international technological competition situation, we should emphasize the importance of independent innovation in core technologies in the field of signals and systems, guide students to recognize the close connection between professional learning and national technological development, help them establish a lofty ideal of building a strong technological nation, and enhance their sense of responsibility to contribute to the development of China's information technology industry.

The rigor of self-tracking antenna system design could be leveraged to cultivate students' awareness of engineering ethics and the spirit of craftsmanship. When explaining system parameter design, we should emphasize the key impact of indicators such as antenna tracking accuracy and stability on the overall performance of the system, and explain that any parameter calculation errors may lead to tracking failures, which in turn may cause serious consequences such as communication interruptions and mission failures, guiding students to develop a rigorous, meticulous, and excellence-oriented work attitude. By analyzing system failures caused by design oversights in actual engineering cases, we can help students understand the social responsibilities that engineers should bear in technological research and development, strengthen engineering ethics concepts such as reliability and safety, and cultivate students' high sense of professional responsibility and dedication.

The integration of curriculum-based ideological and political education elements involves designing corresponding ideological-political integration points by combining different links of self-tracking antenna system teaching cases, so that value shaping runs through the entire process of theoretical explanation, case analysis, and practical operation. This ensures a deep fusion of ideological-political education with professional knowledge transmission and engineering skill cultivation, forming a synergistic educational effect.

3. Implementation of course teaching

The signals and systems course adopts a blended online-offline teaching mode, incorporating intelligent teaching tools and leveraging advanced technologies such as big data and artificial intelligence [11,12]. Through an online learning platform, personalized learning support and guidance are provided to students, which helps stimulate their learning interest and enthusiasm, and enhances their autonomous learning capabilities. Combined with the online learning platform, the flipped classroom approach is implemented. Before class, students preview the course content via the online platform; during class, teachers guide students in in-depth discussions and practical activities; after class, students review and consolidate their knowledge through the online platform. Teaching activities are designed to form a coherent and interlocking three-stage process encompassing pre-class, in-class, and post-class activities. Additionally, a diversified evaluation system that combines process-based and outcome-based assessments is established, achieving a closed-loop optimization of teaching, learning, and evaluation.

3.1. Theoretical teaching activities

Guided by the main thread of pre-class autonomous preview-in-class in-depth discussion-post-class review and consolidation, a coherent and progressive teaching process is constructed by leveraging the synergistic advantages of the online-offline blended teaching mode.

The pre-class phase centers on online autonomous learning, focusing on the impartation and initial understanding of fundamental knowledge. Teachers upload instructional videos explaining theoretical knowledge to the online learning platform, clearly specifying learning objectives, key points, and difficulties. Simultaneously, they provide background materials related to self-tracking antenna system cases for the upcoming class, guiding students to gain a preliminary understanding of engineering scenarios. Online quiz questions are set to assess students' self-learning outcomes. Through data feedback from the platform, teachers can accurately identify students' knowledge weaknesses and adjust the focus of in-class teaching accordingly, ensuring that offline instruction is more targeted.

The in-class phase takes place in the offline classroom, emphasizing ability cultivation and value shaping. Teachers deliver in-depth explanations of difficult content identified from pre-class feedback. Combining self-tracking antenna system cases, they design group discussion topics, guiding students to engage in solution design and debate using knowledge such as frequency-domain analysis and S-domain modeling. This collaborative inquiry process enhances students' ability to solve engineering problems. Meanwhile, elements of curriculum-based ideological and political education are integrated. Through case studies, such as China's breakthroughs in satellite tracking technology, value guidance is provided, achieving the simultaneous advancement of knowledge acquisition and ideological-political education.

The post-class phase relies on online expansion to facilitate knowledge internalization and transfer application. Students are required to complete MATLAB/Simulink simulation assignments related to self-tracking antenna systems, write experimental reports, and outline the application logic of theoretical knowledge in engineering practice. They participate in themed discussions on the platform, sharing problems encountered during simulations and their solutions, deepening their understanding of the knowledge system. Teachers promptly grade assignments and respond to discussions through the online platform, guiding students to translate classroom learning into practical abilities to solve engineering problems.

3.2. Construction of experimental platform

To enhance the practical teaching quality of the signals and systems course, this paper focuses on constructing a practical teaching platform centered around the core content of self-tracking antenna systems from the perspective of teaching modes. An open experimental teaching mode was adopted. Teachers prepare experimental guidelines in advance, clearly defining experimental objectives such as "optimizing the anti-interference performance of self-tracking systems," and providing optional experimental projects, including hardware debugging and software simulation using MATLAB/Simulink, along with outcome requirements. Students autonomously select experimental content, design experimental plans with reference to teacher-provided materials, including parameter settings, step planning, and data collection methods. During experiments, teachers offer guidance both online and offline, promptly addressing technical challenges. Upon completion, students submit reports and outcomes. Teachers evaluate them from dimensions such as plan innovation and operational standardization, provide improvement suggestions, and organize group discussions on experimental results to cultivate students' autonomous learning and innovative spirit.

3.3. Teaching evaluation

Teaching evaluation adopts a combination of formative and summative assessment. In formative assessment, process-based evaluation is incorporated into the grading system, focusing on students' routine performance and learning process. Through methods such as online learning data analysis, simulation assignments, group discussion participation, and experimental reports, students' learning progress is comprehensively evaluated. This approach helps to provide a holistic and objective reflection of students' learning situations, stimulates their learning interest and enthusiasm, and offers references for their future academic and career development.

Summative assessment is conducted through final exams, with exam questions including application-based problems related to engineering cases. This evaluation method comprehensively assesses students' attainment of knowledge, skills, and overall competencies. Special emphasis is placed on the feedback role of evaluation. Through timely analysis of learning data, personalized tutoring and support are provided to address students' difficulties. Additionally, feedback on teaching reforms is collected through student evaluations of teaching and questionnaires, enabling continuous improvement of teaching methods.

4. Evaluation of course teaching effectiveness

Since the initiation of curriculum development oriented toward engineering education professional certification, the signals and systems course has achieved remarkable results through teaching reforms that incorporate engineering case studies. According to a questionnaire survey, over 75% of students believe that the teaching model using engineering case studies enhances their learning interest and practical abilities. Performance analysis indicates that the average grade of students in the reform-oriented class has increased by 16%, with a noticeable rise in the rate of excellent course design projects. Post-course follow-up interviews reveal that students have generally developed a deeper understanding of the connection between signals and systems theory and aerospace engineering practices, leading to increased appreciation for the course.

The integration of curriculum-based ideological and political education has effectively inspired a sense of mission and learning initiative among students. Meanwhile, the diversified assessment system has reduced end-of-term pressure, encouraging students to focus more on daily learning and ability development. Teachers have reported improved classroom participation and teaching engagement, though they have also noted that innovative teaching approaches demand greater time investment and professional expertise from instructors. Based on student evaluations of teaching and questionnaire feedback, students generally express high satisfaction with the curriculum-based ideological and political education, teacher capabilities, and teaching methods, fully demonstrating the positive role of teaching reforms in enhancing learning engagement, interest, and overall effectiveness.

5. Conclusion

This paper has utilized the self-tracking antenna system as a through-line engineering case study for the course, signals and systems. Teaching practice has demonstrated that this reform has yielded significant educational outcomes. From a systematic perspective, this engineering case study links all core knowledge points of the signals and systems course, helping students construct a comprehensive knowledge network of signals and systems rather than isolated mathematical formula-based knowledge points. From the perspectives of cutting-edge relevance and practicality, this engineering case study, derived from current engineering applications in the aerospace field, has greatly enhanced students' learning interest and national mission awareness. From the standpoint of deepening theoretical understanding, applying abstract knowledge such as Fourier transforms, Laplace transforms, Z-transforms, and system functions to solve specific engineering problems in the self-tracking antenna system enables students to truly grasp their physical meanings and engineering values. From the perspective of cultivating thinking abilities, this engineering case study encompasses a wide-bandwidth system ranging from radio frequency signal processing to low-speed servo control, requiring students to approach engineering problems from multiple perspectives, including signal flow, energy flow, and information flow, thereby fostering their analytical and design capabilities for engineering problems.

In summary, the exploration and reform of curriculum development using engineering case studies, represented by the self-tracking antenna system, have provided an effective pathway for transforming the signals and systems course from a theory-oriented to an engineering capability-oriented approach. This is of significant importance for cultivating innovative engineering and technical talents who meet the requirements of engineering education professional certification for solving complex engineering problems.

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Chopstick Use Among Preschool Children in the Year Before School: Performance, Experience, Techniques, and Interest

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Abstract

This study examined chopstick performance among 77 senior-class Chinese preschool children at the beginning of the autumn semester using a standardized chopstick performance test. The relationships among chopstick performance and different chopstick experiences (home and kindergarten), chopstick techniques (action patterns, grip style, grip position), and children's interest levels were investigated. Results indicated that significant differences in chopstick performance existed across children of different ages, genders, chopstick experiences, and interest levels, whereas no significant main effects of chopstick grip style or grip position on performance were found. Both age and home chopstick experience within six months were significant predictors of performance. Based on these findings, we present recommendations for educators and families.

Keywords

Chopstick experience; Chopstick skill; Chopstick technique; Interest in chopstick use; Preschool year

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1. Introduction

The use of spoons, chopsticks, and pencils is fine motor skill involving tool use; in the process of motor acquisition, these three tasks progressively engage shoulder, elbow, wrist, palm, and finger joint movements and muscle control, creating a continuum that supports general transfer of motor learning. Chopstick use plays a critical bridging role in this sequence. Chopstick competence is not only significantly associated with children's self-feeding independence in China, but is also closely related to literacy achievements that rely on pencil manipulation [1,2].

Most studies indicate that age is a factor influencing chopstick skill: children begin to acquire the skill around age four and develop rapidly during the following year, with growth slowing from ages five to eight; by six or seven years old, they demonstrate relatively mature chopstick features [3,4]. Most children already begin to eat independently with chopsticks during the first semester of the senior preschool year [5]. However, different kindergartens vary in when they introduce chopstick practice, and differences in in-kindergarten chopstick experience influence children's chopstick levels [6]. Moreover, action patterns and grip styles during chopstick use relate to stability, adaptability, and performance [7]. Adult performance with pincer-type grips often outperforms scissor-type grips [8,9]. While prior work has examined relationships between grip style and grip position, the effect of grip position on performance remains underexplored. Likewise, although some research explores individual preferences in chopstick use, literature focusing on children's intrinsic interest in chopstick activities is scarce.

Given this gap, the present study aims to examine characteristics of chopstick performance among senior preschool children at the start of the autumn term and to analyze relations between performance and chopstick experience, technique, and interest, providing evidence to inform implementation of the *Guidelines for Learning and Development for Children Aged 3–6 Years* and preparation for handwriting readiness.

2. Research design

2.1. Participants

To examine differences associated with in-kindergarten chopstick experience, 77 senior-class children were randomly selected from two public kindergartens in Xi'an China (39 boys, 38 girls). Chronological ages ranged from 59.37 to 72.47 months (mean = 66.27 months, SD = 4.08 months). Kindergarten 1 gradually introduced chopstick use beginning in the middle-class (mid-level preschool), with near-universal adoption by the later semester; Kindergarten 2 began full chopstick use at the start of the senior class. Both kindergartens provided chopstick meals 2–3 times daily. All children were right-handed, had normal or corrected vision, and no developmental disorders. Parents read and signed informed consent forms.

2.2. Instruments and procedure

2.2.1. Family chopstick experience questionnaire

A self-developed *Preschool Children's Family Chopstick Experience Questionnaire* was distributed to parents in the first week of the autumn semester (with the informed consent form). The questionnaire assessed the child's chopstick age at home (duration), and home chopstick frequency: "often uses chopsticks during meals" "occasionally uses chopsticks" or "never uses chopsticks."

2.2.2. Chopstick performance test

We developed a standardized chopstick performance test based on motor tasks in domestic and international child development scales and ergonomic research on chopstick dimensions. Wooden chopsticks were chosen (length 240 mm; tip diameter 4 mm; handle diameter 6 mm).

Before testing, children performed simple tasks (threading beads, drawing) to observe handedness and were asked verbally about their habitual chopstick hand. Each child sat at a table of appropriate height. Ten cereal rings and a small bottle (mouth diameter 28 mm; height 55 mm) were placed in front of the child; the bottle and cereal rings were 17 cm from the table edge, with cereal rings spaced 10–20 cm apart to avoid contact. Children were instructed to use chopsticks to pick up cereal rings one by one and place them into the bottle as quickly as possible. Timing started when the child picked up the first ring and ended when the tenth ring was placed into the bottle. The total time (in seconds) represented the child's chopstick performance.

The test was conducted one week after questionnaire distribution. We replaced peanuts (commonly used in earlier studies) with cereal rings because rings present a moderate challenge and allow weaker performers to utilize the hole in the ring (< 4 mm) during grasping, the material is less likely to break or roll away, easy to identify, and safe if moistened.

During testing, video recordings were taken from an angle of approximately 135° from the child's left side to right frontal area to capture finger characteristics, positions, and movement patterns (1080p, 30fps) for later coding.

2.2.3. Chopstick interest rating scale

After the performance test, children rated their interest in chopstick use on a five-point Likert scale (1 = strongly dislike using chopsticks; 5 = strongly like using chopsticks). To accommodate preschool cognition, each response option was accompanied by a cartoon facial expression.

2.3. Data coding

Chopstick-use behavior during the performance test was coded along three aspects: action pattern, grip style, and grip position as outlined below:

(1) Action pattern: Based on Lin et al., ten action patterns (codes 1–10) were used. The first eight matched Lin's categories. Two additional patterns observed in this study were coded: Pattern 9 (full-palm grasp, where all five fingers fix chopsticks in the palm with little division of labor among digits; palm tilts about 90° relative to table; gripping tightness changes achieve clamping) and Pattern 10 (a bimanual cooperative mode originally classified as "undetermined hand form 2" by previous research, involving both hands cooperating to complete pick-up tasks) [10];

(2) Grip style: Coded as Scissor-type = 1; Pincer-type = 2;

(3) Grip position: The grip position was categorized by the ratio of the distance from the thumb–index web (tiger's mouth) to the chopstick tip relative to the total length, into six groups: 1 = between 1/3–1/2; 2 = approximately 1/2; 3 = between 1/2–2/3; 4 = approximately 2/3; 5 = between 2/3–3/4; 6 = ≥ 3/4.

Two raters independently coded the videos; inter-rater agreement reached 100%.

3. Results

3.1. Age differences in chopstick performance

Considering the age distribution of subjects, we divided participants into three groups by 5-month intervals:

(1) Low-aged group: 59–64 months (M = 61.73 months, SD = 1.14);

(2) Middle-aged group: 64–69 months (M = 66.46 months, SD = 1.44);

(3) High-aged group: 69–74 months (M = 70.99 months, SD = 1.04).

Chi-square tests indicated no significant gender differences among the groups ($\chi^2 = 1.83$, d.f. = 2, $P > 0.05$). As shown in **Table 1**, the two-way ANOVA with age group and gender as independent variables and chopstick test completion time as the dependent variable yielded:

(1) No significant age × gender interaction (F = 1.02, n.s.);

(2) Significant main effect of age group on performance (F = 6.12, $P < 0.01$);

(3) Significant main effect of gender: girls performed better than boys (F = 4.57, $P < 0.05$);

(4) Post-hoc comparisons showed significant improvement in performance from around 62 months to 66 months ($P < 0.01$), but changes from 66 months to 71 months were not significant ($P > 0.05$).

Table 1. Age and gender differences in chopstick performance

Age group	Gender	n	Mean (s)	SD
Low-aged (59–64 mo)	Male	15	66.85	50.66
	Female	13	39.77	46.34
Middle-aged (64–69 mo)	Male	9	40.45	16.74
	Female	14	24.42	6.97
High-aged (69–74 mo)	Male	15	26.11	8.58
	Female	11	23.27	14.63
ANOVA	Age group F = 6.12**			
	Gender F = 4.57*			
	Age × Gender F = 1.02 (n.s.)			

Note: *$P < 0.05$; **$P < 0.01$

3.2. Chopstick performance by experience

An independent-samples t-test comparing children with different kindergarten chopstick experience durations showed a significant difference (t = –3.38, $P < 0.01$): children with approximately one year of in-kindergarten chopstick experience performed significantly better than those with less than one month.

The one-way ANOVA examined home chopstick age and home chopstick frequency revealed that home chopstick age had a significant effect (F = 12.85, $P <$

0.001). Children with more than six months of home chopstick experience had significantly better mean performance than those with less than one month (P < 0.001). Differences between the 1–6 months group and other duration groups were not significant (P > 0.05). Improvement beyond six months plateaued (P > 0.05).

Home chopstick frequency had a significant main effect (F = 41.84, P < 0.001). Children who never used chopsticks at home performed significantly worse than those who used them regularly or occasionally (P < 0.001). There was no significant difference between regular and occasional users (P > 0.05).

3.3. Chopstick technique (action pattern, grip style, grip position)

The distribution and performance across action patterns, grip styles, and grip positions are given below.

Significant differences among the ten action patterns (F = 4.79, P < 0.001). However, after removing the two children using Pattern 10 (bimanual), the remaining nine patterns did not differ significantly (F = 1.21, P > 0.05) (**Table 2**).

Table 2. Frequency and performance by action pattern

Action pattern (code)	N (%)	Mean (s)	SD
1	22 (28.6)	27.16	11.76
2	3 (3.9)	30.18	12.09
3	9 (11.7)	41.26	34.28
4	29 (37.7)	33.84	32.02
5	1 (1.3)	32.28	-
6	4 (5.2)	58.71	30.20
7	2 (2.6)	35.34	3.77
8	3 (3.9)	18.00	1.41
9 (full-palm)	2 (2.6)	68.30	67.10
10 (bimanual)	2 (2.6)	152.16	67.98

Grip style had no main effect on performance (F = 0.10, P > 0.05) (**Table 3**).

Table 3. Frequency and performance by grip style

Grip style	N (%)	Mean (s)	SD
Scissor-type	73 (94.8)	37.61	34.78
Pincer-type	4 (5.2)	32.03	7.22

Grip position had no significant main effect (F = 1.70, P > 0.05) (**Table 4**).

Table 4. Frequency and performance by grip position

Grip position	N (%)	Mean (s)	SD
1/3–1/2	8 (10.4)	54.63	60.37
≈ 1/2	38 (49.4)	29.52	16.10
1/2–2/3	7 (9.1)	47.54	63.71
≈ 2/3	14 (18.2)	31.57	21.53
2/3–3/4	3 (3.9)	66.36	51.99
≥ 3/4	7 (9.1)	48.67	34.52

A significant interaction between action pattern and grip position was found. For Pattern 3, performance when grip position was 2/3–3/4 was significantly worse than when grip position was 1/2 or 2/3 (P < 0.05). For Pattern 4, performance at 1/2–2/3 was significantly worse than at 1/2 (P < 0.05).

3.4. Chopstick performance by interest levels

A one-way ANOVA with interest level as the independent variable and completion time as the dependent variable revealed a significant effect (F = 3.24, P < 0.05). Children who strongly disliked using chopsticks had significantly lower performance than children at other interest levels (P < 0.05). Differences among the other interest levels were not significant (P > 0.05).

3.5. Regression: Predicting chopstick performance

We performed a stepwise regression with chopstick performance as the dependent variable and predictors including kindergarten chopstick age, home chopstick age, home usage frequency, action pattern, interest level, age (months), and gender.

Three variables entered the final model:

(1) Age (standardized β = –0.227, t = –2.58, P <

0.05);

(2) Home chopstick age: < 1 month (β = 0.587, t = 6.63, $P < 0.001$);

(3) Home chopstick age: 1–6 months (β = 0.208, t = 2.51, $P < 0.05$).

These results indicate that age and home experience within the first six months are significant predictors of chopstick performance (adjusted $R^2 = 0.485$; F = 24.82; $P < 0.001$). Compared to technique, interest, and gender, experience, particularly early home experience, had the strongest influence on performance.

4. Discussion

This study found that at the beginning of the senior preschool year, after roughly one week in-class exposure to chopstick use, most children, regardless of prior experience, could complete the basic chopstick transfer task, though two children required bimanual cooperation to succeed. This finding aligns with prior research regarding the typical age range for acquiring chopstick skills [1]. However, marked individual, gender, and age-related differences were evident. A potential developmental inflection point may exist between 62 and 66 months, during which acquisition speed is highest. Girls displayed superior performance to boys, possibly due to earlier maturation of musculoskeletal structures, which confers physiological advantages for fine motor tasks.

A central discovery was the predictive significance of home experience within six months, implying a critical period for consolidating chopstick skills during the initial six months of practice. This aligns with literature showing rapid skill development during the first year of learning, followed by a plateau [4]. Skilled chopstick users, through repeated practice, accumulate sensorimotor experience that likely promotes functional cortical reorganization in motor-related brain regions; experienced users therefore require fewer attentional resources and show different neural activation patterns [11]. The initial months of practice may be particularly important for establishing these neural adaptations.

Except for the two bimanual users, we did not find significant associations between specific technique categories and performance. This differs from adults' findings, where pincer grips often lead to higher efficiency [8]. The discrepancy may reflect the early developmental stage: immature fine motor control and small hand size in young children may constrain the benefits of certain grip styles, making technique-related performance differences less apparent at this stage [12]. Finally, we observed that very low interest in chopstick use was associated with poorer performance, indicating that motivational factors influence engagement and motor coordination in early skill acquisition.

5. Conclusions

5.1. Attend to individual differences

During early chopstick learning phases, teachers should carefully attend to individual and gender differences. Children with less than six months of experience need sustained support and habit formation strategies. In kindergartens introducing chopsticks only in the senior class, teachers should especially monitor younger children in the group.

Meal durations should be assigned flexibly according to children's development; educators must avoid pressuring slower children based on faster peers' dining speeds. Where possible, kindergartens should adapt food size, shape, and texture to match children's chopstick proficiency, thereby creating a proximal zone of development for individualized motor skill advancement.

5.2. Strengthen home-school collaboration

Given compact daily schedules and fixed mealtimes in many kindergartens, initiating chopstick learning solely at school may burden teachers and produce discomfort for children who need more time. Home-school collaboration should extend chopstick exposure across time (introduce practice about six months before full implementation at school) and space (integrate practice into family mealtimes and play).

Parents should model proper chopstick use and encourage imitation. Introducing chopstick-related games at home and in classroom play centers can provide rich pre-practice experiences, ensuring children enter formal school mealtime practice better prepared.

5.3. Maintain interest and facilitate transfer to pencil use

Chopstick skill acquisition consolidates upper-limb coordination established by spoon use and improves palm muscle control and proximal phalange mobility, foundational components for fine finger movements in handwriting. Teachers should avoid rigid enforcement of a single grip style; since grip development is constrained by hand maturation, overly strict correction may reduce interest and hinder learning.

Targeted guidance should focus on children whose grip styles clearly impede performance. Practical methods include demonstrating efficient grips during shared meals, engaging children in chopstick games that show more efficient techniques, and using attractive child-friendly training chopsticks. These strategies foster gradual transition to more efficient grips and support transfer from chopstick use to pencil-based tasks.

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The Influencing Factors, Mechanism and Intervention Enlightenment of University Lecturers' Job Burnout: A Literature Review Based on Multi-Dimensional Research

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Abstract

This literature review, based on 7 core studies, explores university lecturers' job burnout. Defined via Maslach's three-dimensional OLBI's two-dimensional models, it is measured mainly by scales like MBI, OLBI, and BMS, with cross-national prevalence differences. Core influencing factors include emotional intelligence vs. emotional labor; psychological well-being and task-oriented coping; professional identity/satisfaction vs. heavy workload/role conflict. Situational factors include COVID-19-worsened burnout via online teaching issues; cultures shape burnout. Limitations include cross-sectional designs and self-report reliance. Future research needs longitudinal methods and objective indicators. Three-level interventions are proposed to provide a theoretical basis for targeted support.

Keywords

Deindividuation; Emotional exhaustion; Job burnout; University lecturers

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1. Introduction

Globally, workplace mental health has become an important public health challenge. According to the International Labour Organization (ILO), about 10% of workers suffer from chronic stress, anxiety, job burnout or depression for a long time, which has become the second leading cause of unemployment, absenteeism, early retirement and even hospitalization [1]. Lecturers, as a typical profession with high emotional involvement, have become a high-risk group of job burnout because of their continuous emotional needs, high-intensity interpersonal interaction and multi-task load. As the core force of higher education, university lecturers not only perform the dual responsibilities of teaching and scientific research, but also undertake the tasks of academic management and student guidance. In addition, changes in the external environment, such as the reform of the European Higher Education Area (EHEA) and the transformation of online teaching during the epidemic, have further exacerbated the complexity of job burnout [2].

Although the existing studies have explored the formation mechanism of job burnout of university lecturers from the aspects of emotional intelligence, psychological well-being, coping strategies, and so on, the systematic integration of different cultural backgrounds, dynamic situational variables, and mediating and regulating paths is still insufficient. Therefore, based on seven core literatures, this paper reviews the concept and measurement of job burnout, key influencing factors and mechanisms, situational differences and health consequences, and research limitations and future prospects, aiming to systematically sort out the multi-level influencing factors and their paths of job burnout of university lecturers, and to provide a theoretical basis for the construction of targeted psychological intervention strategies.

2. Definition and measurement tools of university lecturers' job burnout

Since Freudenberger first proposed the concept of job burnout in 1974, Maslach and other scholars have gradually formed a widely accepted three-dimensional structure model, which includes emotional exhaustion, deindividuation or cynicism. And a reduced sense of personal accomplishment [3]. In the follow-up study, the division of dimensions was further adjusted according to different cultural and occupational situations. For example, the Oldenburg Burnout Inventory (OLBI) simplifies it into two core dimensions of "exhaustion" and "alienation", which are more suitable for measuring job burnout in the context of collectivist culture. It avoids the cultural adaptability problems that may exist in the dimension of "personal accomplishment" [4]. Other studies have reconstructed "personal accomplishment" as "occupational efficacy" to more clearly reflect its positive protective role in alleviating burnout [2].

In terms of measurement methods, the existing studies mainly use self-report scales. Among them, Maslach Burnout Inventory (MBI) and its revised version are the most widely used: MBI-ES is dedicated to the education industry and is often used to assess the performance of university lecturers in the three dimensions of emotional exhaustion, depersonalization and personal accomplishment [1]. As a general version, MBI-GS is suitable for various occupational groups through three dimensions of emotional exhaustion, cynicism and occupational efficacy [2]. The OLBI focuses on the characteristics of emotional labor of university lecturers, focusing on the two dimensions of "exhaustion" and "alienation", which effectively avoids the limitations of "personal accomplishment" in MBI in cross-cultural research [4]. In addition, the Brief Burnout Scale (BMS), which contains only 10 items and is suitable for rapid screening of groups such as lecturer candidates, has a good reliability with an α coefficient of 0.91 for Cronbach's [5].

According to the results of cross-national measurement, there are obvious differences in the prevalence of job burnout among university lecturers in different countries. Among university lecturers in Spain, 20.83 percent of individuals have emotional exhaustion, 5.26% show depersonalization, and 49.74% have low self-actualization [5]. Among Chinese university lecturers, 31.9% showed a high level of burnout, and women were more likely to have emotional exhaustion, while men were more likely to show personalized tendencies [6]. Among the Turkish lecturer candidates, 17% belong to the high burnout group, and 60.4% are in the medium burnout level [5]. These data reveal that job burnout is not only universal among university lecturers, but also shows obvious differences due to different cultural and social backgrounds.

3. Core influencing factors and mechanism of job burnout of university lecturers

Emotion-related variables are the core internal factors affecting job burnout of university lecturers, which mainly affect the burnout process through "emotional regulation ability" and "emotional expression needs". Emotional intelligence (EI) is defined as "the ability to perceive, understand, and regulate one's own and others' emotions", and its three dimensions are significantly associated with job burnout [7]. Puertas-Molero studied 1316 Spanish university lecturers and found that emotional clarity and emotional repair negatively predicted emotional exhaustion ($\beta = -0.13/\beta = -0.09$), and positively predicted personal accomplishment ($\beta = 0.22/\beta = 0.45$), indicating that clearly recognizing emotions and actively repairing negative emotions can reduce emotional resource consumption [1]. Emotional attention was positively associated with emotional exhaustion (β

= 0.27), and excessive attention to negative emotions aggravated burnout.

Emotional clarity and emotional repair also indirectly reduce burnout through non-verbal communication, and the positive correlation coefficients between emotional clarity and non-verbal communication are 0.215 and 0.249, respectively. Martel and Santana further verified the "sequential development model" of emotional intelligence: emotion perception (basic dimension) → emotion understanding → emotion regulation (higher-order dimension) [2]. Emotional regulation not only directly affects emotional exhaustion or occupational efficacy (β = 0.002/β = -0.055), but also can improve self-acceptance, positive relationship and other dimensions of psychological well-being (β = 0.554). It indirectly reduced negative burnout (β = -0.537) and improved occupational efficacy (β = 0.752), which confirmed the full mediation of psychological well-being.

Emotional labor refers to "the process of regulating emotional expression in order to meet the requirements of work", which can be divided into three categories: surface play, deep play and natural emotional expression [8]. A study of 1128 university lecturers in Pakistan showed that emotional labor positively predicted two dimensions of burnout, exhaustion (β = 0.414, $P < 0.001$) and alienation (β = 0.302, $P = 0.003$), and the negative effect of surface play was the most significant [4]. Empathy played a partial mediating role in the relationship between emotional labor and exhaustion (indirect effect = 0.090, 95% CI = 0.03–0.125). Although high empathy can promote the relationship between lecturers and students, it can also aggravate the consumption of emotional resources and form "empathy burden".

Gender played a moderating role: male lecturers were more likely to be exhausted under the influence of emotional labor (interaction effect = 0.133, 95% CI = 0.035–0.225), which may be related to the gender norms of male "emotional suppression" in Pakistani culture. Psychological well-being (PWB) is based on Ryff's multidimensional model, covering six core dimensions of self-acceptance, positive relationship, autonomy, environmental control, personal growth and life goals, which is the key mediator between individual internal resources and job burnout [9]. In addition to the path of "emotion regulation → psychological well-being → burnout" verified, the study in Spanish university lecturers provided further affirmation on the concept [2,5]. Multiple sub-dimensions of psychological well-being were significantly and negatively correlated with burnout: overall psychological well-being (β = -0.097) and sense of environmental control (β = -0.104) could effectively alleviate emotional exhaustion, while positive social relations (β = -0.126) could help reduce the tendency of depersonalization. It shows that good psychological state and environmental adaptability have a direct effect on alleviating burnout. Moreover, the study also found that lecturers with low self-actualization (49.74%) were more likely to have sleep disorders (R = 0.287) and emotional eating behavior (R = 0.292), which further verified the protective function of psychological well-being on job burnout from the perspective of physical and mental health.

Cynicism is reflected in the general suspicion of other people's motives and the alienation of organizational norms, which plays an important intermediary role between lecturers' job burnout and well-being. A study on 326 lecturer candidates in Turkey showed that job burnout not only significantly positively predicted the level of cynicism (β = 0.56, $P < 0.01$), but also negatively affected individual well-being (β = -0.70, $P < 0.01$) [5]. Structural equation model analysis further showed that cynicism had a significant negative predictive effect on well-being (β = -0.40, $P < 0.01$), and played a partial mediating effect between burnout and well-being (indirect effect = -0.39, 95% CI [-0.45, -0.33]). The study points out that lecturer candidates are more likely to form cynical attitudes because they face severe job competition (admission rate of civil service examination is less than 2%), thus exacerbating the vicious circle between burnout and declining well-being.

Coping strategies and defense mechanisms constitute lecturers' behavioral and psychological response system in the face of occupational stress, and their types and frequency of usage directly affects the development of burnout. Zhao and Ding conducted a study on 204 university lecturers in China, which showed that task-oriented coping strategies (such as active problem solving) were significantly related to low burnout level (t = 2.764, $P = 0.007$), while lecturers with high burnout were more likely to use emotion-oriented coping (such as emotional catharsis, t = -8.037, $P < 0.001$) and avoidance-oriented coping [6]. In terms of defense mechanisms, lecturers with high burnout tended to rely on immature defense styles, such as transfer ($t = -4.450$, $P < 0.001$) and regression ($t = -2.959$, $P = 0.004$), while lecturers with low burnout tended to use "denial" and "compensation" mechanisms to relieve stress through cognitive reconstruction and value transfer. In addition, the study among university lecturers in Pakistan adds that older lecturers are more likely to use adaptive strategies such as "positive reconstruction" and "religious help-seeking", while younger lecturers tend to use "psychological disengagement" to cope with stress, which shows that there are significant age differences in the use of coping strategies [10].

Career identity reflects the individual's internal acceptance and commitment to their professional values and roles, while job satisfaction reflects the overall positive evaluation of work experience, both of which are important predictors of job burnout. Based on the survey data of 483 Chinese university lecturers during the epidemic, Chen found that both professional identity ($\beta = -0.923$, $P < 0.001$) and job satisfaction ($\beta = -0.462$, $P < 0.001$) had a significant negative predictive effect on job burnout [11]. Further mediating effect analysis showed that job satisfaction played a partial mediating role between professional identity and burnout, with a mediating effect value of -0.225 (95% CI [-0.62, -0.41]), indicating that professional identity not only directly alleviated burnout, but it can also indirectly reduce the level of burnout by improving job satisfaction.

University lecturers often face the conflict between the multiple roles of "teaching-research-management", which constitutes an important external incentive for job burnout. Tello pointed out that there was a significant positive correlation between emotional exhaustion and workload of Spanish university lecturers ($R = 0.608$), and voice fatigue caused by long-term teaching was also closely related to emotional exhaustion ($\beta = 0.174$, $P < 0.001$) [5]. The research further shows that "teaching-research conflict" can indirectly aggravate job burnout by weakening lecturers' self-efficacy, while perceived leadership support can alleviate such negative effects to some extent [12].

4. College lecturers' job burnout under situational differences: Moderating effects of epidemic situation and culture

The outbreak of COVID-19 has promoted the systematic transformation of teaching mode and provided a unique contextual background for exploring job burnout of university lecturers. The research shows that the multiple challenges faced by online teaching during the epidemic, including technical barriers, blurred work-family boundaries and declining quality of interpersonal interaction, have jointly led to a significant increase in the level of lecturer burnout [11].

Based on the survey data of 483 Chinese university lecturers, the study further reveals that lecturers' professional identity and job satisfaction during the epidemic are lower than baseline level before the epidemic, and the accumulation of online teaching experience is positively correlated with the degree of burnout, that is, the longer they are engaged in online teaching, the higher the burnout scores reported by lecturers. Furthermore, lecturers with inadequate technical preparation are more likely to suffer from emotional exhaustion due to the pressure of teaching adaptation, and the effective technical support provided by school organizations can buffer the negative impact to some extent.

Emotional expression norms and professional role expectations under different cultural backgrounds significantly affect the manifestation and formation mechanism of lecturers' job burnout, showing distinct cross-cultural differences. In countries dominated by collectivist culture, lecturers are generally constrained by the norm of "emotional suppression" and tend to avoid expressing negative emotions to students. This cultural expectation leads to surface acting as a common emotional labor strategy, which aggravates the consumption of emotional resources and burnout [4]. In Turkey, lecturer candidates face a highly competitive employment environment, especially the extremely low admission rate in the civil service examination, which leads to career anxiety that significantly increases the level of cynicism and indirectly exacerbates the development of burnout [13]. In contrast, in cultures such as Spain that emphasize work-life balance, burnout among university lecturers is more related to lifestyle factors. Studies have shown that lifestyle habits such as sedentary behavior ($R = 0.109$) and sleep disorders ($R = 0.287$) have a more prominent impact on burnout, reflecting the moderating role of cultural values in shaping burnout pathways [5].

5. Research limitations and future research directions

Although the existing studies have systematically discussed the multi-dimensional influencing factors of job burnout of university lecturers, there are still some limitations in research design, sample and measurement methods, and variable coverage:

(1) Most empirical studies adopt cross-sectional design, it is difficult to establish the causal relationship between variables, especially the possible two-way influence mechanism between emotional intelligence and job burnout [11];

(2) Most of the existing studies focus on a single country or cultural background, lacking systematic cross-cultural comparative analysis. On top of that, the measurement tools mainly rely on self-report scales, although some studies have not found serious common methodological bias through Harman's one-way test, but still need to introduce objective behavioral or physiological indicators to improve data validity [4];

(3) Some potential factors, such as work-family conflict, peer support and institutional policy, have not been fully incorporated into the theoretical model. At the same time, there is still a lack of follow-up research on the long-term consequences of job burnout.

Based on the above limitations, future research can be further expanded from the following three aspects:

(1) Methodologically, it is suggested that longitudinal research design or experience sampling method should be used to dynamically track the development trajectory of burnout, and objective indicators (such as cortisol level, classroom behavior observation) and subjective reports should be integrated to enhance the causal inference power and ecological validity of research results;

(2) In terms of theoretical construction, we should expand the investigation of emerging variables, such as "work-life balance" and "digital teaching ability", in order to more comprehensively reflect the reality of contemporary university lecturers' work and its relationship with burnout;

(3) In practice, we should strengthen the intervention research based on empirical evidence, and design targeted intervention programs according to the verified influence mechanism, such as carrying out emotional intelligence training to enhance lecturers' emotional clarity and repair ability, or implementing organizational support programs to alleviate role conflict and provide psychological counseling, and scientifically evaluate their effectiveness.

6. Conclusion

Based on seven core literatures, this review systematically combs the concept, influencing factors and mechanism of job burnout of university lecturers, and draws the following core conclusions:

(1) College lecturers' job burnout has high universality, and emotional exhaustion, depersonalization and low self-actualization are the core manifestations, which are significantly affected by culture and situation;

(2) Emotional intelligence, psychological well-being and adaptive coping strategies are the core protective factors of burnout, while emotional labor, workload and cynicism are the risk factors;

(3) Psychological well-being, job satisfaction and other variables play a mediating role in the formation of burnout, while gender and culture play a moderating role.

Based on the above conclusions, three levels of intervention implications are proposed:

(1) At the individual level, lecturers' emotional intelligence and adaptive coping strategies can be improved through training, and the emotional labor played on the surface can be reduced.

(2) At the organizational level, we should emphasize on optimizing work design, establishing lecturers' mental health monitoring and support system;

(3) At the policy level, we should improve the evaluation system of university lecturers, balance "scientific research output" and "teaching quality", pay attention to lecturers' professional development and work-life balance, and reduce the risk of burnout from the institutional level.

The mental health of university lecturers is not only related to personal well-being, but also affects the quality of higher education and the development of students. In the future, it is necessary to build a "individual-organization-policy" collaborative intervention system through multi-disciplinary collaboration to provide more systematic support for the prevention and alleviation of job burnout among university lecturers.

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The Impact of the "Internet + Artificial Intelligence" Era on College Students' Innovation and Entrepreneurship

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Abstract

Under the tide of the "Internet + Artificial Intelligence" era, new momentum has been injected into college students' innovation and entrepreneurship. Based on the background of the times, this paper systematically analyzes the development space expanded, technical support provided, market demand spawned, and collaborative models optimized by this environment for college students' innovation and entrepreneurship. At the same time, it directly faces practical challenges such as accelerated technological iteration, insufficient practical capabilities, intensified market competition, and difficulties in resource integration. From four dimensions, interdisciplinary education reform, practical platform construction, deep cultivation of segmented fields, and construction of a diversified support system, targeted practical paths are proposed to provide reference for college students to seize the opportunities of the times, break through entrepreneurial bottlenecks, help them achieve high-quality innovation and entrepreneurship in the new technological environment, and inject youthful vitality into the innovative development of the economy and society.

Keywords

College students; Internet + artificial intelligence; Innovation and entrepreneurship; Interdisciplinary education; Practical paths

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1. Introduction

The in-depth integration of digital technology and intelligent technology has promoted "Internet + Artificial Intelligence" to become the core engine of global innovative development. Against this backdrop, innovation models, industrial forms, and market demands have undergone profound changes. The threshold for innovation and entrepreneurship has been continuously lowered, and the space has been continuously expanded [1]. As a group with active thinking and eagerness to accept new things, college students are an important new force in innovation and entrepreneurship. Stimulating their innovation and entrepreneurship vitality and improving their capabilities are not only related to their personal growth and development, but also of great significance for promoting economic restructuring and nurturing new drivers of development.

Currently, innovation and entrepreneurship education in colleges and universities is constantly advancing, but the knowledge transmission and practical training under the traditional model can no longer meet the development needs of the "Internet + Artificial Intelligence" era. When college students carry out innovation and entrepreneurship using new technologies and platforms, they face unprecedented opportunities as well as many new difficulties [2]. Based on this, this paper analyzes the impact of the "Internet + Artificial Intelligence" era on college students' innovation and entrepreneurship, explores practical paths adapting to the requirements of the new era, and provides useful reference for improving the quality of college students' innovation and entrepreneurship and improving the relevant support system.

2. The impact of the "internet + artificial intelligence" era on college students' innovation and entrepreneurship

2.1. Expanding the broad space for innovation and entrepreneurship

The popularization and application of the Internet have broken geographical restrictions, and the breakthrough of artificial intelligence technology has spawned a large number of new formats and models, opening up multiple tracks for college students' innovation and entrepreneurship. Traditional innovation and entrepreneurship are restricted by factors such as funds, venues, and channels, with a high threshold. However, in the "Internet + Artificial Intelligence" environment, college students can build online platforms without huge initial investment to carry out entrepreneurial projects such as e-commerce, content creation, and technical services. The in-depth integration of artificial intelligence with various industries has given birth to emerging fields such as intelligent education, smart medical care, and intelligent logistics.

These fields have strong market demand and are in the initial stage of development, providing a broad space for innovation for college students. For example, college students can develop personalized learning assistance systems for specific groups based on artificial intelligence technology, or build regional agricultural product traceability and sales platforms based on big data analysis. In addition, the maturity of technologies such as cloud computing and SaaS services allows college students to obtain the required computing resources and software tools at low cost without investing a lot of money in infrastructure construction [3]. This has greatly reduced the start-up cost of entrepreneurship, enabling more college students with ideas and abilities to participate in innovation and entrepreneurship, and the possibility of innovation and entrepreneurship has been greatly expanded.

2.2. Providing efficient and intelligent technical tools

The development of technologies such as big data, artificial intelligence, and cloud computing has provided strong technical support for college students' innovation and entrepreneurship, running through all links such as market analysis, product development, and precision marketing. In the stage of market analysis, college students can use big data analysis tools to collect and sort out information such as consumer behavior, demand preferences, and competitive patterns in the target market, quickly grasp market dynamics, accurately identify market gaps, and provide a scientific basis for the positioning of entrepreneurial projects to avoid blind decision-making [4]. In the process of product development, artificial intelligence technology can simulate product usage scenarios, predict product performance, optimize product design schemes, shorten the R&D cycle, and reduce R&D costs. For example, in the field of software development, artificial intelligence code generation tools can assist in completing repetitive coding work and improve development efficiency. In the field of industrial design, intelligent design software can quickly generate multiple design schemes for selection according to user needs.

Through in-depth analysis of user data using artificial intelligence algorithms, accurate user portraits can be outlined, and then personalized product information and service content can be pushed to improve marketing conversion rates. Cloud computing technology provides stable and efficient storage and computing support for entrepreneurial projects, ensuring the smooth operation of online platforms, allowing college students to focus on core businesses and improve the efficiency and quality of innovation and entrepreneurship.

2.3. Spawning new demands for personalization and customization

Under the trend of consumption upgrading, consumers are no longer satisfied with standardized and homogeneous products and services, and their demand for personalization and customization is growing day by day. The development of "Internet + Artificial Intelligence" technology has made it technically possible to meet such demands and created new market opportunities for college students' innovation and entrepreneurship [5]. Artificial intelligence technology can quickly process massive amounts of user data, accurately capture the differentiated needs of individual users, and provide data support for the R&D of personalized products and services. Internet platforms have broken information barriers, allowing college students to directly connect with consumers, understand their personalized needs, and realize on-demand production and precision services [6]. For example, in the field of clothing, college students can develop intelligent customization platforms to generate exclusive design schemes according to users' body data and style preferences.

In the field of cultural and creative industries, personalized cultural and creative product design and content creation services can be provided for users based on artificial intelligence technology. Personalized needs in segmented fields are often ignored by large enterprises. With their flexible thinking and quick response capabilities, college students can accurately enter these segmented markets, focus on the personalized needs of specific groups, build differentiated competitive advantages, occupy a place in the niche market, and achieve breakthroughs in innovation and entrepreneurship [7].

3. Challenges faced by college students' innovation and entrepreneurship in the "internet + artificial intelligence" era

3.1. Rapid technological iteration and insufficient knowledge reserve

The technology in the "Internet + Artificial Intelligence" field updates and iterates rapidly, with new algorithms, new models, and new applications emerging continuously, putting forward extremely high requirements for the knowledge reserve and learning ability of innovators and entrepreneurs. Currently, there is a certain lag in the curriculum setting of colleges and universities. The traditional professional curriculum system focuses on theoretical knowledge transmission, which is disconnected from actual industry needs and the forefront of technological development. The knowledge learned by college students during their school years is difficult to keep up with the pace of technological iteration [8]. Most courses related to artificial intelligence and big data are basic theoretical teaching, lacking in-depth explanations of the latest technological applications and industry practical cases, resulting in shortcomings in college students' knowledge systems.

3.2. Lack of technical application capabilities and practical experience

Although college students can access advanced technical tools such as artificial intelligence and big data, most of them only master basic operation methods and lack the application capabilities to combine technology with actual entrepreneurial scenarios. The practical teaching link in colleges and universities is weak, the laboratory equipment is not updated in a timely manner, and there is a lack of simulation of real entrepreneurial scenarios [9]. College students possess difficulties in improving their technical application capabilities through practical training. In addition, college students generally lack industry practical experience, have insufficient understanding of market operation rules, user demand mining, business logic construction, etc., and it is difficult to convert technical advantages into commercial value.

3.3. Intensified market competition and severe homogenization

The threshold for innovation and entrepreneurship has been lowered in the "Internet + Artificial Intelligence" era, and a large number of entrepreneurs have poured into this field, leading to increasingly fierce market competition. Majority of college students' innovation and entrepreneurship projects are concentrated in popular fields such as e-commerce, content creation, and mini-program development [10]. These fields have relatively low technical thresholds and are easy to be imitated and copied, resulting in severe homogenization. Some college students lack in-depth market research and unique thinking, blindly follow popular projects, and lack differentiated competitive advantages. They imitate each other in product design, service models, marketing methods, etc., and it is difficult to form core competitiveness, eventually being eliminated in the fierce market competition.

3.4. Limited entrepreneurial resources and need to improve integration capabilities

Although Internet platforms facilitate access to resources, college students still face the problem of shortage of core resources in the process of innovation and entrepreneurship. In terms of funds, most college students' entrepreneurial projects are in the initial stage, lacking stable profit models and collateral, making it difficult to obtain support from traditional financing channels such as bank loans [11]. Emerging financing methods such as crowdfunding and angel investment have high requirements for project quality and business prospects, and most college students' entrepreneurial projects are difficult to meet the relevant standards, resulting in great financing difficulties. Additionally, college students lack the awareness and ability of resource integration, are not good at using Internet platforms to explore and integrate various resources, and it is difficult to convert scattered resources into entrepreneurial advantages, restricting the development and growth of projects.

4. Practical paths for college students' innovation and entrepreneurship in the "internet + artificial intelligence" era

4.1. Deepening interdisciplinary education and building a dynamic knowledge system

Colleges and universities should break traditional disciplinary barriers, promote interdisciplinary education reform, and reconstruct the innovation and entrepreneurship curriculum system. Centering on the core technologies and industry needs in the "Internet + Artificial Intelligence" field, integrate multi-disciplinary resources such as computer science, big data, management, and economics, and set up interdisciplinary course modules, such as Artificial Intelligence Application and Entrepreneurship Management, Big Data Analysis and Market Operation, to cultivate college students' interdisciplinary thinking and comprehensive capabilities.

Optimizing the course content, timely integrate cutting-edge industry technologies and the latest cases into the teaching process, reducing pure theoretical knowledge explanation, and increasing practice-oriented teaching content could tackle this issue [12]. On top of that, establishment of a continuous learning mechanism and encouragement of college students to update their knowledge reserves through various channels such as online courses, industry seminars, and technical training also aids in this issue. Colleges and universities can build online learning platforms, integrate high-quality learning resources, and provide convenient continuous learning channels for college students.

4.2. Strengthening the construction of practical platforms and improving technical application capabilities

Colleges and universities should strengthen cooperation with enterprises, co-build practical platforms such as artificial intelligence laboratories and innovation and entrepreneurship incubators, introduce the real technical environment, project resources, and industry standards of enterprises, and provide immersive practical experience for college students [13]. Enterprises can send technical backbones and industry experts to participate in practical teaching, guide college students to carry out project R&D, business practice and other activities, and help college students improve their technical application capabilities and practical experience. Implementation of a project-based teaching model, taking real entrepreneurial projects as the carrier, guiding college students to form teams, and participating in the whole process from market research, product design, technical development to market promotion, so as to exercise their ability to solve practical problems in practice strengthens their capabilities as well.

Encouragement of college students to participate in various innovation and entrepreneurship competitions and scientific research projects, such as the "Internet +" College Student Innovation and Entrepreneurship Competition and Artificial Intelligence Innovation Challenge [14]. Through competitions, students can learn and practice, accumulate practical experience, and improve team collaboration and project operation capabilities. Simultaneously, the supporting services of practical platforms should be improved by equipping professional instructors and technical support personnel, providing project consulting, technical guidance, resource docking and other services for college students to ensure the smooth development of practical teaching and entrepreneurial projects, and help college students convert technical knowledge into practical application capabilities.

4.3. Focusing on innovation in segmented fields and cultivating core competitiveness

College students should avoid blindly following popular fields, strengthen market research, conduct in-depth analysis of market demand and competitive patterns, and focus on segmented fields for innovation in combination with their own professional advantages and interests. In the "Internet + Artificial Intelligence" era, personalized and niche market demands are becoming increasingly prominent. College students can tap these under-satisfied demands, deeply cultivate vertical fields, and create differentiated products and services [15].

They should pay attention to the combination of technological innovation and model innovation, improve the technical content of products through continuous R&D investment, form technical barriers, and innovate business models and service models to enhance user experience and market competitiveness. Furthermore, they should also strengthen the protection of intellectual property rights, promptly apply for patents and register trademarks for innovative achievements, safeguard their legitimate rights and interests, and prevent innovative achievements from being infringed [16]. By focusing on segmented fields, strengthening innovation, and protecting intellectual property rights, cultivate core competitiveness, they could gain a foothold in the fierce market competition.

4.4. Building a diversified support system and empowering resource integration

Colleges and universities should improve the innovation and entrepreneurship service system, establish professional innovation and entrepreneurship guidance centers, integrate resources such as on-campus tutors, off-campus industry experts, and successful entrepreneurs, and provide one-on-one entrepreneurship guidance and project incubation services for college students. Resource docking platforms should be built to help college students connect with core resources such as funds, technology, and supply chains, organize activities such as university-enterprise docking meetings and entrepreneurship exchange meetings, and promote cooperation between college students, enterprises, and investment institutions [17]. Enterprises should actively fulfill their social responsibilities, participate in the construction of the college students' innovation and entrepreneurship support system, provide internship positions, project cooperation, technical support and other opportunities for college students, invest in potential college students' entrepreneurial projects, and achieve mutual benefit and win-win results. Through the collaborative efforts of the government, colleges and universities, and enterprises, build a diversified support system, empower college students to improve their resource integration capabilities, and provide comprehensive guarantee for the development of innovation and entrepreneurship projects.

5. Conclusion

In short, college students should seize the opportunities of the times, actively adapt to technological development and market changes, improve their own quality through continuous learning, and focus on segmented fields to cultivate core competitiveness. Colleges and universities, the government, and enterprises should work together to deepen education reform, improve the support system, optimize the entrepreneurial environment, and escort college students' innovation and entrepreneurship. In the future, with the continuous progress of technology and the improvement of the support system, college students' innovation and entrepreneurship will usher in a broader development prospect and bloom greater value in the wave of innovation in the new era.

Disclosure statement

The author declares no conflict of interest.

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Research on the Training Mechanism of Judicial Police Officers under the Cooperation Mode between School and Bureau: Based on the Perspective of Policy Implementation

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Abstract

As a key model for the cultivation of judicial police officers, the effectiveness of school-bureau cooperation is deeply bound to the quality of policy implementation. This article takes policy implementation as the entry point, combines the development history of policies and adaptation theories, and analyzes the logic of the role of collaborative implementation subjects, resource allocation, and process norms in talent cultivation. It further clarifies the connotations and operation modes of three core mechanisms, collaborative formulation of training programs, joint construction of "dual-qualified" teachers, and integration of practical teaching. On this basis, the study proposes optimization strategies including the collaborative governance of multiple actors, precise supply of educational and practical resources, and dynamic assessment of implementation outcomes. These strategies aim to provide practical support for realizing the professional and practice-oriented training of judicial police officers and to promote the high-quality development of political and legal teams.

Keywords

Collaborative governance; Judicial police officer; School-bureau cooperation; Policy implementation; Talent cultivation mechanism

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1. Introduction

Under the background of the deepening of the judicial administrative system reform and the advancement of the professionalization of the political and legal teams, the cooperation between schools and bureaus has become the core path for the cultivation of judicial police officers. The implementation effectiveness of relevant policies directly determines the quality of talent cultivation. This paper, from the perspective of policy implementation, focuses on the construction of the talent cultivation mechanism for judicial police officers under the school-bureau cooperation model. By combining the laws of policy evolution and theoretical support, and through methods such as literature research and logical analysis, it defines core concepts such as school-bureau cooperation, policy implementation, and the talent cultivation mechanism for judicial police officers, and sorts out the existing research results and deficiencies. The aim is to explore the impact dimensions of policy implementation on talent cultivation, clarify the core components of the mechanism, propose optimization paths, provide theoretical references for enhancing the pertinence and effectiveness of judicial police officer talent cultivation, and contribute to the construction of the political and legal talent team and the development of the judicial administrative cause.

2. The policy basis and theoretical support for the cooperation between schools and bureaus in cultivating judicial police officers

2.1. The evolution and core content of policies related to the cultivation of judicial police officers

The development of policies for cultivating judicial police officers is closely linked to the national judicial administrative reform and the strategy of building the political and legal teams. It has roughly gone through three stages: initial exploration, standardized development, and in-depth improvement.

The early policy was mainly based on the independent cultivation of institutions, with an emphasis on the teaching of basic theories. With the increasing demand for professionalization of the political and legal teams, policies have gradually emphasized practical orientation and explicitly proposed the training direction of cooperation between schools and bureaus. In recent years, relevant policies have been further refined, forming systematic regulations covering training objectives, resource allocation, and assessment and evaluation.

The core content is concentrated in three aspects:

(1) It clarifies the standards for cultivating the political quality, professional ability and practical skills of judicial police officers;

(2) It establishes the collaborative responsibility of colleges and judicial administrative organs in talent cultivation;

(3) It proposes policy guarantee measures to promote the implementation of cooperation, providing clear policy guidance for the development of the school-bureau cooperation model [1].

2.2. Policy positioning and implementation basis of the school-bureau cooperation model

The school-bureau cooperation model holds a core position in the policy system for cultivating judicial police officers and is a key carrier for implementing the talent cultivation strategy of the political and legal teams. At the policy level, it is positioned as an important way to integrate the educational resources of colleges and universities with the practical resources of judicial administrative organs. Through the collaboration of the two, the deep integration of theory and practice is achieved, and the problem of the disconnection between theory and practice in the traditional training model is solved. The implementation basis of this model mainly stems from three types of policy documents, including the macro-strategic planning at the national level on the cultivation of political and legal talents, which clarifies the overall direction of cooperation between the university and the bureau. The special policies jointly issued by the judicial administrative department and the education department standardize the specific contents and operational procedures of cooperation. The supporting implementation measures formulated by local authorities in light of their actual conditions, and the detailed cooperation measures in response to the demands of regional judicial administration, together form the institutional support for the orderly advancement of the school-bureau cooperation model.

2.3. Theoretical adaptability of the talent cultivation mechanism from the perspective of policy implementation

To study the talent cultivation mechanism of school-bureau cooperation from the perspective of policy implementation, it is necessary to build an analytical framework based on relevant theories, and the theories should be highly compatible with the research topics. The policy implementation theory provides a core perspective for analyzing the transformation process of school-bureau cooperation policies from text to practice. Through elements such as policy implementation subjects, resources, and processes, it can be explored how policies affect the operation of the talent cultivation mechanism. The theory of collaborative governance applies to explaining the cooperation logic between educational institutions and judicial administrative organs, clarifying the division of rights and responsibilities, communication and coordination, and interest integration mechanisms between the two in talent cultivation, and providing theoretical support for building an efficient collaborative training system. Furthermore, human capital theory reveals the intrinsic connection between talent cultivation and social demands, which can guide the school-bureau cooperation mechanism to precisely set the training content and methods around the human capital demands in the judicial administrative field, ensuring a high degree of matching between talent cultivation and job requirements, and enhancing the actual effectiveness of policy implementation [2].

3. Dimensions of the impact of the implementation of school-bureau cooperation policies on the cultivation of judicial police officers

3.1. The guiding role of the collaborative implementation of policy subjects on the training objectives

The implementation of the school-bureau cooperation policy involves two core subjects: universities and judicial administrative organs. The degree of coordination between the two directly affects the precise positioning and realization direction of the talent cultivation goals for judicial police officers. The professional and practical requirements for talent cultivation in the policy text need to be transformed into specific training orientations through the joint efforts of both sides. As the main battlefield for talent cultivation, colleges and universities are responsible for imparting theoretical knowledge and shaping basic abilities, while judicial administrative organs, relying on their front-line practical experience, clearly define the core qualities and ability standards required for positions. If there is a lack of effective communication and coordination between the two sides in the implementation of policies, it is easy to lead to a disconnection between the training objectives and the demands of judicial practice, resulting in the separation of theory and practice. Conversely, by establishing a regular collaborative mechanism and unifying the understanding of training objectives in line with policy requirements, it can ensure that talent cultivation always meets the actual needs of the construction of the judicial administrative team, achieving a precise orientation from "knowledge-based" to "practical" talent cultivation [3].

3.2. The guarantee effect of policy resource allocation on training conditions

The allocation of resources during the policy implementation process is a key foundation for supporting the cultivation of judicial police officers. Its rationality and sufficiency directly determine the quality of the training conditions. The requirements for the allocation of resources such as teaching staff, funds and practical venues clearly stipulated in the policy need to be scientifically allocated and efficiently utilized between universities and judicial administrative organs. The resource advantages of colleges and universities are reflected in their disciplinary systems, research platforms and theoretical teaching staff, while judicial administrative organs have practical venues, first-line cases and practical talent resources.

In the implementation of policies, if the allocation of resources lacks overall planning, problems such as insufficient practical resources in colleges and universities and the difficulty in effectively converting high-quality practical resources of judicial administrative organs into teaching resources will arise, which will restrict the improvement of training conditions. By implementing policy requirements and promoting the in-depth integration of resources between both sides, such as jointly building training bases, sharing teaching staff, and coordinating the use of funds, a stable resource guarantee can be provided for talent cultivation, significantly enhancing the adaptability and support of training conditions, and laying a solid foundation for practical training [4].

3.3. The regulatory function of the policy implementation process on the training stage

The standardization of the implementation process of the school-bureau cooperation policy plays an important role in constraining and regulating the orderly advancement of each link in the training of judicial police officers. The requirements for the curriculum setting, teaching implementation, assessment and evaluation and other processes of talent cultivation in the policy are the core basis for connecting the entire cultivation chain. From the perspective of the construction of the curriculum system, it is necessary to update the course content in accordance with the requirements of policy processes and in combination with judicial practice to avoid the solidification of the curriculum setting.

In the teaching implementation stage, the policy enforcement process clarifies the integration path of theoretical teaching and practical teaching, and standardizes the procedures for formulating and adjusting teaching plans. In the assessment and evaluation stage, the policy process requires breaking away from the single assessment model and introducing diversified evaluation standards involving judicial administrative organs. A standardized implementation process can effectively avoid the arbitrariness of the training links, thereby ensuring that all links, such as course setting, teaching implementation, and assessment and evaluation always revolve around policy goals, forming a closed-loop training system and enhancing the systematicness and standardization of talent cultivation [5].

4. The core components of the talent cultivation mechanism in the implementation of school-bureau cooperation policies

4.1. A collaborative formulation mechanism for training programs based on policy objectives

As the core blueprint for the training of judicial police officers, the formulation of the training program must strictly adhere to the core goal of the relevant policies on school-bureau cooperation, that is, to cultivate applied and compound talents that meet the job requirements of the judicial administrative system. This mechanism breaks the traditional model of single formulation by universities and establishes a collaborative decision-making system between universities and judicial administrative organs. Colleges and universities, in accordance with the policy requirements for talents' knowledge, ability and quality, and in combination with their disciplinary advantages, sort out the basic framework of the curriculum system. Judicial administrative organs, based on the actual functions of front-line law enforcement, management and other positions, provide suggestions on job competency standards and career development needs.

Through regular communication and coordination, universities and judicial administrative organs have detailed the relevant policy requirements for school-bureau cooperation into specific training objectives, curriculum Settings, credit structures and assessment standards. Through this process, the training program not only adheres to the inherent laws of education and teaching but also precisely meets the actual needs of judicial police positions under policy guidance, thereby achieving a deep integration and seamless connection between the set policy goals and the specific content of talent cultivation, laying a foundation for the precise training of judicial police talents [6].

4.2. A "dual-qualified" teacher co-construction mechanism relying on policy resources

The "dual-qualified" teaching staff is a key support for the cooperation between universities and judicial administrative organs in cultivating judicial police officers. This mechanism is based on the resource sharing requirements clearly stipulated by policies and builds a two-way co-construction system of teaching staff between universities and judicial administrative organs. Colleges and universities select teachers with solid theoretical foundations within the school in accordance with policy guidance. Through the practical training platforms provided by judicial administrative organs, they participate in front-line business practices, business training and research projects to enhance their practical teaching abilities.

Meanwhile, judicial administrative organs, in accordance with policy regulations, select and dispatch front-line law enforcement officers, managers and other personnel who are highly skilled and experienced. After undergoing teaching ability training in colleges and universities, they undertake tasks such as practical course teaching, practical training guidance and graduation design tutoring. In addition, both sides will jointly establish a teacher assessment and incentive system, linking the effectiveness of teacher co-construction during policy implementation with assessment and evaluation, professional title assessment, etc., to ensure the stability and professionalism of the teaching staff and provide a teacher guarantee that combines theoretical depth and practical experience for talent cultivation [7].

4.3. A practical teaching integration mechanism closely adhering to policy requirements

Practical teaching is the core link in the cultivation of professional abilities for judicial police officers. This mechanism closely adheres to the normative requirements of policies for practical teaching and builds an integrated system of "combining learning with application and integrating knowledge with action". In accordance with the policy regulations on the duration, content and standards of practical teaching, universities and judicial administrative organs jointly plan the practical teaching links, integrating the business processes, work norms and real cases of the judicial administrative system into the practical teaching content, and setting up progressive practical modules such as cognitive internships, professional training and on-the-job internships.

By establishing fixed practice bases and implementing job rotation practices, students are enabled to deeply participate in front-line work, thereby honing their law enforcement capabilities, emergency response skills and professional qualities in practice. At the same time, both sides jointly formulate practical teaching assessment methods, based on the job ability standards required by policies, to conduct a comprehensive evaluation of students' practical performance, ensuring that the entire process of practical teaching conforms to policy guidance and effectively enhances the practical application ability of talents.

5. Optimize the talent cultivation mechanism and path for the implementation of school-bureau cooperation policies

5.1. Build a collaborative governance system for policy implementation subjects

The efficient collaboration among policy implementation subjects is the key to the implementation of the talent cultivation mechanism through school-bureau cooperation. It is necessary to break down the barriers between universities and judicial administrative organs, establish a collaborative governance structure with clear rights and responsibilities, clarify the specific duties and collaborative processes of both sides in talent cultivation, and avoid shirking and disconnection in policy implementation. By establishing a regular communication platform, precise alignment can be achieved in aspects such as training objectives, teaching content, and practical arrangements, ensuring that policy requirements can be effectively conveyed and transformed into concrete actions.

At the same time, it is necessary to strengthen the trust and interest coordination mechanism between universities and judicial administrative organs, and to comprehensively resolve problems such as uneven resource distribution and ambiguous division of rights and responsibilities during the cooperation process. By establishing an efficient and interactive system and constructing a closed-loop management model of "decision-making - execution - feedback", we ensure smooth connection and clear responsibility in each link of policy implementation, continuously enhancing the efficiency of policy collaborative implementation by both the school and the bureau, and laying a solid institutional foundation for the stable and orderly operation of the school-bureau cooperative talent cultivation mechanism [8].

5.2. Improve the guarantee mechanism for the precise supply of policy resources

The rational allocation of policy resources directly affects the quality of talent cultivation through school-bureau cooperation. We should take policy requirements as the guide, establish a precise matching mechanism for resource supply, focus on the core demands of talent cultivation, and integrate the teaching resources of universities with the practical resources of judicial administrative organs. In terms of teaching resources, promote mutual employment and dispatch of personnel between the two sides in accordance with policy standards to ensure the stable construction of the "dual-qualified" teaching staff. In terms of practical resources, relying on the business platforms of judicial administrative organs, standardized practical bases should be established to ensure an adequate supply of practical teaching resources. At the same time, a dynamic adjustment mechanism for resources should be established. According to policy changes and training demands, the structure of resource allocation should be optimized in a timely manner. The supervision and evaluation of resource usage should be strengthened to avoid resource waste and ensure that policy resources can efficiently serve all links of talent cultivation, laying a solid material foundation for the operation of the mechanism [9].

5.3. Improve the dynamic assessment mechanism for the implementation effect of policies

Dynamic assessment is an important means to test the effectiveness of policy implementation and optimize the talent cultivation mechanism. Based on policy goals and talent cultivation standards, a scientific evaluation index system should be established, covering core dimensions such as the implementation of the training program, the quality of the teaching staff team building, the effectiveness of practical teaching, and feedback on talent cultivation quality. Establish a diversified assessment subject, integrate the forces of universities, judicial administrative organs, industry experts and graduates, and form a comprehensive assessment perspective. At the same time, a dynamic assessment platform should be established to conduct regular assessment work, promptly collect data and information during the policy implementation process, deeply analyze the problems reflected in the assessment results, and form a virtuous cycle of "assessment - feedback - optimization". Through regular assessment, unreasonable links in the talent cultivation mechanism are adjusted in a timely manner to ensure that policy implementation always meets the needs of talent cultivation and continuously enhance the effectiveness of talent cultivation through cooperation between the university and the bureau [10].

6. Conclusion

From the perspective of policy implementation, this article systematically explores the relevant issues of the talent cultivation mechanism for judicial police officers under the school-bureau cooperation model. By sorting out the policy basis and theoretical support, the evolution logic of the talent cultivation policy for judicial police officers, the policy positioning of school-bureau cooperation, and the theoretical adaptability have been clarified. The specific impact of policy implementation on talent cultivation was analyzed from three dimensions: the implementing subject, resource allocation, and process norms. It has defined three core mechanisms: collaborative formulation of training programs, joint construction of "dual-qualified" teachers, and integration of practical teaching. And propose optimization paths such as building a collaborative governance system for the main body, improving the precise supply mechanism of resources, and perfecting the dynamic assessment mechanism. Although the research provides theoretical and practical ideas for the improvement of the talent cultivation mechanism through school-bureau cooperation, there are still deficiencies in aspects such as the in-depth analysis of the reasons for the differences in policy implementation. In the future, research can be further deepened in combination with regional practices to promote the precise alignment of policy implementation and talent cultivation mechanisms, providing more powerful support for the professionalization of the judicial administrative team.

Disclosure statement

The author declares no conflict of interest.

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Research on the Practice of AI-Enabled Project-Based Teaching Model in Student Science and Technology Associations from the Perspective of Exquisite Classroom

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Abstract

Rooted in the context of new curriculum reforms, this study adopts an action research approach combined with case verification to explore the practical model of artificial intelligence technology empowering project-based teaching in student science and technology associations, aiming to address the practical dilemmas of fragmented traditional teaching and scattered resources in science and technology associations. The research constructs a practical model integrating the concept of exquisite classroom, develops interdisciplinary practice cases based on the transformation of information technology curriculum achievements, and effectively realizes the integration of teaching resources and optimization of learning processes. The research conclusions indicate that this practical model provides an operable implementation path for the deep empowerment of AI technology in primary and secondary school science and technology association education, and has positive significance for improving the educational quality of science and technology association activities and students' core literacy.

Keywords

Artificial intelligence empowerment; Exquisite classroom; Student science and technology associations; Project-based learning

Online publication: August 26, 2025

1. Introduction

With the in-depth advancement of new curriculum reforms and the widespread penetration of artificial intelligence technology in the education field, constructing a teaching system with deep integration of "science" and "technology" has become an important direction of current educational development. The "Opinions of the Ministry of Education and Other Nine Departments on Accelerating the Promotion of Educational Digitalization" issued in 2025 clearly proposes the strategic requirement of "promoting the deep integration of artificial intelligence and education and teaching, and innovating teaching models and evaluation methods", providing policy guidance for educational digital transformation. In this context, problems such as the separation of disciplinary knowledge and technical application in traditional science and technology association teaching models, and the lack of systematic design in student science and technology association projects have become increasingly prominent, restricting the comprehensive development of students' core literacy.

Current educational practice faces dual challenges: on one hand, there is a "two skins" phenomenon where theoretical teaching is disconnected from technical practice; on the other hand, student science and technology association activities mostly remain at shallow exploration oriented by interest, lacking project-based learning design and process evaluation mechanisms based on real problems. Domestic and foreign studies have shown that AI-enabled project-based learning can effectively address the above dilemmas. Foreign scholars have confirmed through empirical studies that AI-supported project-based learning can improve students' critical thinking ability by 32% and collaborative ability by 28%; domestic related practices have shown that science and technology association activities integrated with AI tools can significantly improve students' innovative awareness and practical ability. This research, based on this interdisciplinary field, explores the implementation path of AI-empowered project-based teaching in student science and technology associations from the perspective of exquisite classroom, which has important theoretical and practical value.

This paper will adopt the research framework of "theoretical construction-model design-practice verification-reflection optimization", first combing the theoretical basis of AI education and project-based learning, then constructing a science and technology association project-based teaching model integrating AI technology, testing its application effect through empirical research, and finally forming a promotable teaching practice paradigm. This research not only helps to enrich the interdisciplinary research results of educational technology and curriculum teaching theory, but also provides practical reference for primary and secondary schools to implement educational digital transformation requirements.

2. Theoretical basis and concept definition

2.1. Exquisite classroom

A highly effective teaching system constructed with student development as the center through precise goal positioning, detailed process design, and exquisite achievement presentation. Its core characteristics are reflected in the accuracy of teaching goals, the interactivity of teaching processes, and the diversity of teaching evaluation. This model emphasizes supporting with a structured teaching framework and achieving the unity of knowledge transfer and ability cultivation by optimizing teaching links [1].

2.2. Artificial intelligence empowerment

Refers to reconstructing teaching processes through artificial intelligence technology to achieve data-driven personalized learning support. Its core value is reflected in three levels: real-time collection and analysis of learning behavior data, intelligent planning of personalized learning paths, and precise matching and push of teaching resources.

2.3. Project-based learning

A teaching model centered on real-world problems, where students complete project tasks through interdisciplinary knowledge integration and collaborative inquiry. This approach emphasizes deep student engagement in practical processes, focusing on developing problem-solving skills, innovative thinking, and teamwork abilities. Its implementation typically involves five stages: project initiation, planning, execution, monitoring, and final presentation of outcomes [2].

2.4. Theoretical logic of the trinity integration

The integration of exquisite classroom, artificial intelligence empowerment and project-based learning constructs a "structure-technology-practice" trinity teaching system. The exquisite classroom provides a structured framework for teaching implementation, through the "three rings and five steps" model, including goal ring, process ring, evaluation ring; problem raising, scheme design, inquiry practice, achievement extraction, reflection and expansion, ensuring the systematicness and standardization of the teaching process.

Artificial intelligence technology, as a key support, realizes full data collection of learning process through

AIoT devices, provides personalized learning support through intelligent analysis algorithms, and provides teachers with basis for precise teaching intervention. Project-based learning serves as the practice carrier, transforming abstract knowledge into concrete practice through interdisciplinary project tasks, and realizing the deep integration of "learning by doing" and "doing by learning" under the structural guidance of exquisite classroom and intelligent support of AI technology (**Figure 1**).

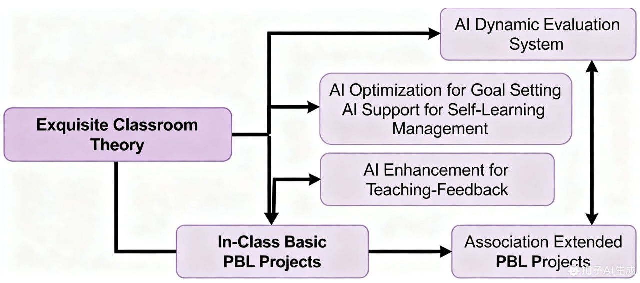

Figure 1. "Classroom-association dual cycle" project-based teaching model.

The goal ring of the "three rings and five steps" model focuses on core literacy cultivation, the process ring integrates AI tools to support inquiry practice, and the evaluation ring achieves precise feedback through multi-dimensional data. Process data collected through IoT devices can improve the accuracy of personalized learning recommendations by 37% and project completion efficiency by 29%, confirming the promoting effect of technology empowerment on PBL implementation. Exquisite classroom builds the teaching framework, artificial intelligence technology injects the intelligent core, and project-based learning fills the practice content, together forming a new teaching paradigm of "precise goal-intelligent process-in-depth practice", providing a systematic solution for in-depth learning in student science and technology association activities.

3. Construction of practice model

The construction of the "Exquisite Classroom + AI + PBL" practice model needs to follow the systematic principles and structured design, ensuring the collaborative optimization of the educational ecology through three major principles:

(1) Goal stratification emphasizes decomposing knowledge mastery, ability cultivation and value shaping into three progressive dimensions according to Bloom's educational goal classification theory: basic level, advanced level, and innovative level;

(2) Technology adaptation requires selecting matching AI tools according to teaching scenarios, such as using natural language processing technology to assist Chinese text analysis and computer vision technology to support biological experiment observation;

(3) Process regulation establishes a closed-loop adjustment mechanism of "early warning-intervention-optimization" through dynamic monitoring of learning behavior data.

The core elements of this model are reflected in the in-depth linkage between classroom and association, scenario-based application of AI tools, and systematic design of interdisciplinary projects. The classroom, as the main position for knowledge transfer, is responsible for consolidating disciplinary foundations and AI skill enlightenment; student science and technology associations realize knowledge transfer through real project practice, forming an ability training chain of "theoretical learning-technical training-innovative application".

In terms of AI tool application, it is necessary to build a "perception-analysis-creation" three-level application system: the primary stage uses AI teaching assistant systems to achieve personalized tutoring, the intermediate stage cultivates analytical ability through data visualization tools, and the advanced stage carries out innovative design with generative AI. Interdisciplinary project design should focus on real problems, such as campus carbon neutrality projects integrating multidisciplinary knowledge of mathematical modeling, physical energy conversion, and chemical substance circulation, realizing the organic integration of "science" and "technology" through AI carbon emission monitoring systems [3].

Its operational mechanism forms a complete closed-loop through the coordinated execution of three phases:

(1) The pre-class phase sets differentiated objectives based on learner profiling systems, such as assigning AI-powered micro-lessons on key concepts to students with weaker foundations

and providing project-oriented resource packs to more capable learners;

(2) During class, "dual-teacher collaboration" is implemented: teachers focus on knowledge construction and critical thinking guidance, while the AI system delivers real-time process feedback, such as using learning analytics to identify problem-solving obstacles and push relevant resources;

(3) Post-class, learning chains extend through technology-based club activities. After completing project deliverables, students undergo a comprehensive assessment combining AI evaluation and teacher review, forming a spiral-upward path of "goal setting-practical exploration-reflective improvement."

This practice model breaks through the time and space limitations of traditional teaching, and realizes the in-depth integration of disciplinary knowledge (science) and AI technology (technology) in project practice through the dual-cycle design of "classroom foundation-association expansion". Classroom teaching ensures the systematicness of knowledge system, while science and technology association activities endow knowledge application scenarios. AI technology runs through as a link, not only improving learning efficiency, but also cultivating computational thinking and innovative ability.

In specific implementation, attention should be paid to balancing the relationship between technology application and teaching essence, avoiding cognitive superficialization caused by overuse of AI tools. By establishing a "human-machine collaborative" teaching community, AI undertakes repetitive work, and teachers focus on high-level thinking cultivation, ultimately realizing the educational paradigm transformation from "knowledge imparting" to "literacy cultivation".

4. Implementation strategies of AI-enabled project-based teaching in student science and technology associations

The implementation of AI-enabled project-based teaching in student science and technology associations needs to construct a systematic strategy integrating curriculum development, teacher training and evaluation system to ensure the deep integration of technology application and teaching practice.

At the curriculum development level, focus should be placed on creating discipline-integrated resource packages, including modular content as shown in **Figure 2 that** integrates artificial intelligence technology tools and multidisciplinary knowledge systems to form a three-stage curriculum structure of "basic cognition-technical application-project practice". The resource package should be accompanied by specific project case libraries, step-by-step operation guides and open source code

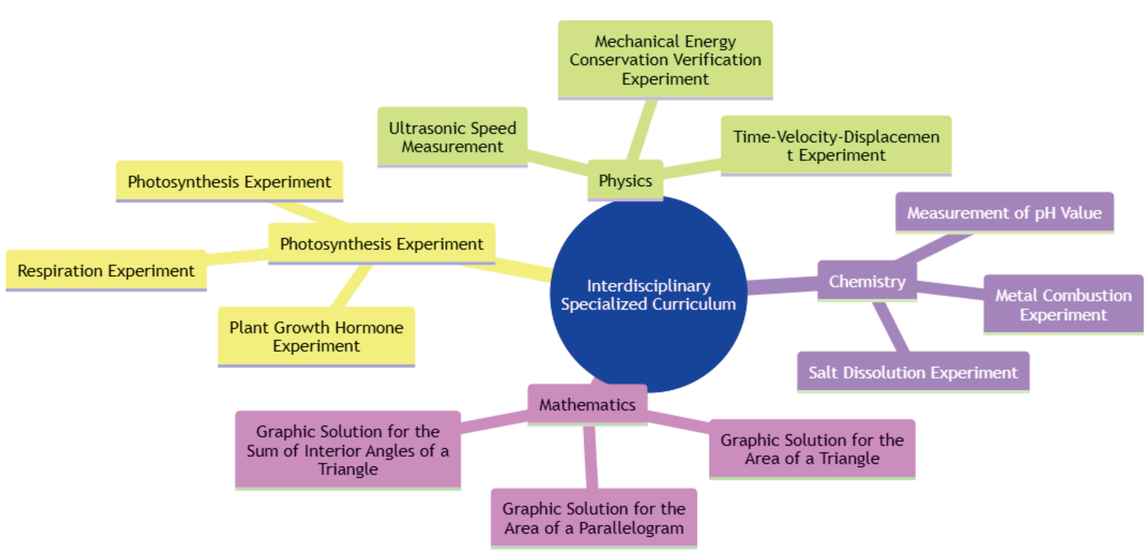

Figure 2. Discipline integration curriculum planning map.

templates to reduce the technical application threshold for association instructors.

Science and technology association curriculum education based on inquiry practice is committed to developing a set of science and technology association courses integrated with information technology. This curriculum closely follows the primary and secondary school discipline outlines, aiming to deepen students' understanding of primary and secondary school science and related discipline courses, design corresponding experimental projects according to the characteristics of different disciplines, and systematically expand project-based and interdisciplinary science courses, with appropriate addition of interesting and interactive elements to enhance students' learning interest.

The teacher training mechanism should establish a university-middle school collaborative training model, draw on the technical support experience of local normal universities, and construct a training system of "theoretical research + practical workshop + continuous guidance". University expert teams can provide cutting-edge training content, such as artificial intelligence education theory and project-based teaching methodology, while middle school teachers transform technical application schemes combined with science and technology association practice scenarios, forming a positive cycle of "university technology input-middle school practice transformation-teacher-student co-creation". Actively carry out centralized training, establish online Q&A communities and monthly technical salons to ensure teachers can continuously obtain professional support.

The evaluation system construction should break through the traditional result-oriented model and develop an AI dynamic evaluation system to achieve process tracking. This system can generate multi-dimensional evaluation reports by analyzing data such as code submission records, team collaboration logs, and problem-solving paths in the project process, including indicators such as technical application proficiency, innovative thinking index, and team contribution. At the same time, it is necessary to retain the weight of teachers' subjective evaluation, adopting a composite evaluation model of "AI data analysis (60%) + teacher comprehensive evaluation (30%) + student mutual evaluation (10%)", which not only ensures the objectivity of evaluation, but also pays attention to students' personalized development [5].

To promote the implementation of strategies, it is necessary to establish a normalized application guarantee mechanism. For instance, incorporating AI science and technology association projects into the school's characteristic curriculum system, expanding influence through backbone teacher demonstration classes and cross-school project exchange exhibitions. It is recommended to hold school-level AI project achievement exhibitions every semester, set up special funds to support the iterative optimization of excellent projects, and establish a student project portfolio system to record the growth trajectory of technical application ability, ultimately forming a complete implementation closed loop of "curriculum support-teacher guarantee-evaluation drive-mechanism escort".

5. Conclusion

Through theoretical construction and practical exploration, this research systematically constructs a "Exquisite Classroom + AI + PBL" trinity teaching model for student science and technology associations, develops an interdisciplinary teaching case library covering scientific inquiry, humanistic creation and other fields, and effectively responds to the core question raised in the introduction: "How to improve the accuracy and innovation of science and technology association teaching through technology empowerment". Practice shows that this model has achieved remarkable results in optimizing teaching processes and stimulating students' in-depth participation, providing an operable practice paradigm for the integration of technology and teaching in information technology curriculum reform. Future research will advance in two aspects:

(1) Expand the pilot scope to different types of schools and establish a regional collaborative research mechanism;

(2) Deepen the integration of AI technology and disciplinary knowledge graphs, develop intelligent teaching platforms with learning analysis and personalized recommendation functions, and further release the potential of technology-empowered education.

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Disclosure statement

The authors declare no conflict of interest.

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Analysis of Brand Plagiarism Using "Pepsi-Cola"

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Abstract

This study focuses on "Pepsi-Cola" and its plagiarized counterpart "B*á*i Shi Cola", analyzing trademark plagiarism from three dimensions: character graphics, phonetics, and pragmatics. In terms of character graphics, it compares the two brands' Chinese character structure, semantic differences (e.g., "Pepsi (B*ǎ*i Shi)" meaning "all things" vs. "B*á*i Shi" meaning "funerals"), and visual similarity (confusable component "R*ì*" in "B*ǎ*i" and "Bái"). Phonetically, a high similarity in sound wave, duration (e.g., 4.829751 seconds for Beijing males), and formats was found from samples from Beijing/Shaanxi speakers via Praat software, with only minor pitch/end-of-sound differences. Pragmatically, similar characters/packaging can easily confuse low-literacy groups due to China's educational disparities. Linguistically and legally, "B*ái S*hi Cola" causes confusion, carries cultural offensiveness, and violates China's Trademark Law. Collectively, these findings support trademark infringement judgment and well-known brand protection.

Keywords

Character graphic analysis; Phonetic quantification (Praat); Pragmatic confusion; Trademark infringement; Trademark plagiarism

Online publication: August 26, 2025

1. Introduction

In the Spanish dictionary of the Royal Academy of Spain, plagiarism is defined as the act of "substantially copying another's work as one's own" [1]. [1]From a legal point of view, plagiarism is an infringement of the copyright of any type of artistic or intellectual work, which occurs when other people's works are presented as their own work or original work [2].

To explore the phenomenon of trademark plagiarism, the Chinese brand "Pepsi-Cola" (B*ǎ*i Shi Cola) and its imitation (Bái Shi Cola) was chosen, as this case provides an illustrative example of how brand identity can be replicated or distorted through subtle linguistic and visual modifications. In this study, the two trademarks will be examined from three perspectives: graphic design, pronunciation and pragmatics.

2. Graphic analysis

2.1. Structural composition of the characters

In Chinese linguistics, characters are generally classified into two main categories: simple characters without radicals and compound characters that contain radicals [3]. In the case of the trademarks “Bǎi Shi Cola” and “Bái Shi Cola”, both consist of four characters, with the only distinction appearing in the first character. Structurally, the trademarks share a similar composition; each character functions as an independent unit rather than a combination of radicals.

The character “Bǎi” is ideographic in nature and can be conceptually divided into two ideograms, “Yī” (one) and “Bái” (white). This reflects a common phenomenon in imitation branding, where plagiarized trademarks replicate or slightly modify the ideographic features of the original [4].

In contrast, the character “Kě” contains a radical and exhibits a semi-enclosed structure. Specifically, the horizontal stroke “Yī” and the vertical hook partially surround the radical “Kǒu” (mouth), forming an integrated visual unit [5]. This structural composition demonstrates the complexity of Chinese character formation, which contributes to the nuanced visual similarities often exploited in trademark plagiarism.

2.2. Semantic and ideographic interpretation

Chinese is a very interesting and special language due to its writing, pronunciation and meaning isolated from each character. This feature allows for subtle yet significant differences in interpretation, particularly in the context of brand naming.

In the original trademark “Bǎi Shi Cola”, the character “Bǎi” is composed of the ideograms “Yī” and “Bái”. When combined, “Bǎi” signifies “one hundred,” symbolically representing abundance or completeness. The character “Shi” denotes “matter,” “event,” or “affair.” Together, “Bǎi Shi” metaphorically conveys “all things” or “everything.” The final two characters, “Cola” (Kě Lè), combine “Kě”, meaning “able to” or “can,” and “Lè”, meaning “happiness” or “joy.” Thus, “Bǎi Shi Cola” literally translates to “happiness in everything” or “everything can be joyful.”

By contrast, the plagiarized version “Bái Shi Cola” replaces the first character “Bǎi” (hundred) with “Bái” (white). While visually similar, the semantic shift is substantial. The compound “Bái Shi” in Chinese refers to funeral affairs or events associated with death, a phrase that carries distinctly negative connotations. When combined with “Cola”, the resulting phrase ironically implies “finding joy in funerals” or “happiness in death,” which is socially inappropriate and contextually absurd in Chinese culture [6]. This stark semantic contrast illustrates how minor graphical changes can lead to major pragmatic misinterpretations.

2.3. Visual similarity and perceptual confusion

From a visual perspective, the two trademarks “Bǎi Shi Cola” and “Bái Shi Cola” are nearly identical, differing only in the first character. Both “Bǎi” and “Bái” share similar strokes and contain the ideographic component “Rì” (sun) in their graphical structure. This close resemblance easily leads to perceptual confusion, especially for individuals unfamiliar with Chinese orthography or for consumers making quick visual judgments [8].

Such minimal variations are a common strategy in trademark plagiarism, exploiting the visual similarity between characters to mislead consumers while maintaining superficial distinctness for legal evasion. This phenomenon underscores the complexity of trademark protection in logographic writing systems like Chinese, where meaning, sound, and form are tightly interwoven, and where even slight visual alterations can carry profound linguistic and cultural implications.

3. Phonetic analysis

This section examines the phonetic characteristics of the original and plagiarized trademarks using acoustic analysis in Praat software. The analysis focuses on five primary dimensions:

(1) The waveform shape displayed by the Praat program;

(2) The pitch contour of each pronunciation;

(3) The terminal shape of the sound line;

(4) The overall duration of the utterance;

(5) The distribution of formant frequencies [9].

To ensure linguistic diversity and capture regional phonetic variation, speech samples were collected from four native Chinese speakers: one male and one female from Shaanxi Province, and one male and one female from Beijing. The Shaanxi dialect, originating from Xi’an, the ancient capital of thirteen Chinese dynasties, retains deep historical and phonological significance within northern China. In contrast, the Beijing dialect, which closely aligns with Standard Mandarin, provides a contemporary benchmark for modern pronunciation.

By comparing these recordings, the study aims to identify how regional accents and tonal variations influence the phonetic realization of the two trademarks, "Bǎi Shi Cola" and "Bái Shi Cola", and to determine whether such variations affect listeners' perception of brand authenticity and distinctiveness [10].

3.1. Phonetic features of "Bǎi Shi Cola"

The phonetic features of the original trademark (Bǎi Shi Cola) were first examined using the speech sample produced by the female speaker from Beijing, whose pronunciation closely corresponds to Standard Mandarin norms.

From the acoustic analysis of the Beijing female speaker's sample, the Praat output reveals six distinct intervals along the pitch contour (blue line), with visible upper and lower boundaries corresponding to pitch variation across the syllables. The measured fundamental frequency (F_0) reaches a peak of approximately 343.26 Hz, while the final pitch falls to around 80 Hz, indicating a natural falling intonation at the end of the utterance. The total duration of the pronunciation is 3.18 seconds, demonstrating balanced timing and articulation across the four syllables. Regarding the formant structure, the first three formants were extracted to examine vowel quality and resonance characteristics [11]. The first formant (F_1) is measured at 813.19 Hz, the second formant (F_2) at 1730.82 Hz, and the third formant (F_3) at 2887.34 Hz. These values fall within the expected range for standard Mandarin vowel production, reflecting clear and stable articulation (**Figure 1**).

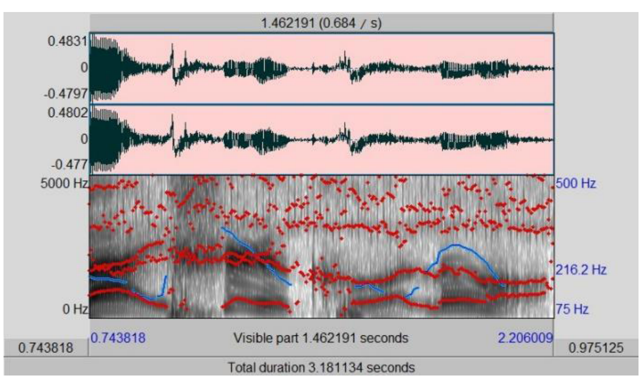

Figure 1. The phonetic analysis of Beijing female speaker.

Next, the Praat analysis of the Beijing male speaker's sample reveals six discernible intervals along the pitch contour, characterized by two prominent peaks and two lower troughs, indicating greater tonal fluctuation compared to the female speaker's recording. The F_0 reaches approximately 282.44 Hz, while the final pitch descends to around 300 Hz, suggesting a mild falling terminal intonation. The total duration of the utterance is 4.83 seconds, notably longer than the female sample, reflecting a slower and more deliberate speech tempo. Regarding the formant frequencies , the analysis identifies the F_1 at 1170.68 Hz, F_2 at 1745.31 Hz, and F_3 at 2618.29 Hz [12]. These values indicate slightly broader vowel resonance and lower harmonic concentration compared to the female sample, possibly due to physiological differences in vocal tract length and pitch range between male and female speakers (**Figure 2**).

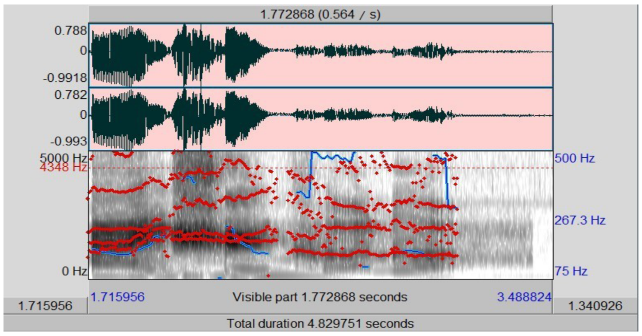

Figure 2. The phonetic analysis of Beijing male speaker.

The Praat analysis of the female speaker from Xi'an (Shaanxi dialect) reveals a distinctive pitch pattern compared to the Beijing samples. The initial segment of the pitch contour appears relatively flat, ranging from approximately 250 Hz to 240 Hz, indicating a stable onset with minimal tonal variation. This is followed by a brief pause and a subsequent sharp rise in pitch, succeeded by a gradual decline toward the end of the utterance. The average F_0 is measured at 249.54 Hz, while the final pitch drops to 0 Hz, signifying complete voicing cessation at the end of the phrase. The total duration of the pronunciation is 4.24 seconds, slightly shorter than that of the Beijing male speaker but longer than the Beijing female speaker's sample. In terms of formant frequencies, the F_1 registers at approximately 842.81 Hz, F_2 at 1770.05 Hz, and F_3 at 2955.34 Hz [13]. These values are within the expected range for Mandarin vowels but show slightly higher resonance in the second and third formants, reflecting the regional characteristics of the Shaanxi dialect, which often features more pronounced vowel articulation and tonal breadth (**Figure 3**).

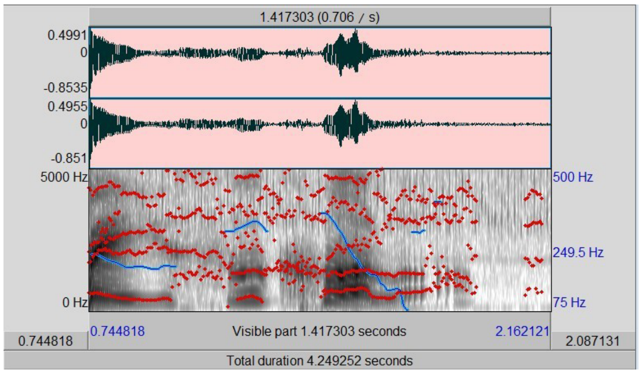

Figure 3. The phonetic analysis of Xi'an female speaker.

The Praat analysis of the male speaker from Xi'an (Shaanxi dialect) reveals a relatively compact pitch contour, with the highest point reaching approximately 450 Hz and the lowest point at 0 Hz, indicating a wide tonal range over a brief segment. The average F_0 is measured at 216.06 Hz, reflecting the naturally lower pitch typical of male speakers. The total duration of the utterance is 4.02 seconds, slightly shorter than the Xi'an female sample, suggesting a slightly faster articulation rate. The formant analysis includes the first four formants to capture more detailed resonance characteristics [14]. The F_1 is 1021.77 Hz, F_2 is 1716.02 Hz, F_3 is 2824.81 Hz, and F_4 is 4057.77 Hz. These values indicate a robust vocal resonance profile, with a broader distribution in higher formants compared to the female Xi'an sample, likely reflecting both physiological differences and dialectal articulation features (**Figure 4**).

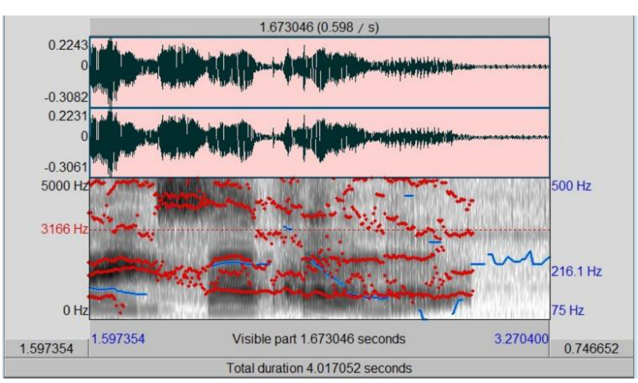

Figure 4. The phonetic analysis of Xi'an male speaker.

3.2. Phonetic features of "Bái Shi Cola"

The Praat analysis of the Beijing female speaker's pronunciation of the plagiarized trademark "Bái Shi Cola" reveals a pitch contour largely similar to that observed in the original brand, characterized by notable tonal volatility. The F_0 is approximately 230.97 Hz, with the terminal pitch descending slightly to 230 Hz, indicating a downward intonation at the end of the utterance. The total duration of the pronunciation is 3.72 seconds, slightly longer than the original sample. Regarding the formant structure, the F_1 is measured at 831.46 Hz, and F_2 at 1808.04 Hz, reflecting clear vowel articulation consistent with Standard Mandarin phonetic norms [15] (**Figure 5**).

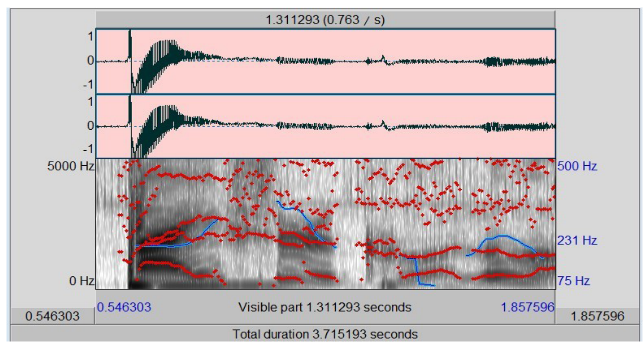

Figure 5. The phonetic analysis of Beijing female speaker.

The Praat analysis of the Beijing male speaker's pronunciation of the plagiarized trademark "Bái Shi Cola" provides insight into vowel distribution and pitch dynamics. In the spectrogram, regions of high intensity (black areas) correspond to vowels, while gray areas indicate the absence of vowels. Five distinct vowels are observable in this sample, separated by four intervening pauses. The pitch contour is composed of small, segmented lines, culminating in a rising terminal pitch of approximately 300 Hz. The average F_0 is 264.21 Hz, and the total duration of the utterance is 4.83 seconds, consistent with the original male sample. Regarding formant frequencies, the F_1 is 1171.32 Hz, and F_2 is 1712.64 Hz, reflecting typical vowel resonance for male Standard Mandarin speakers (**Figure 6**).

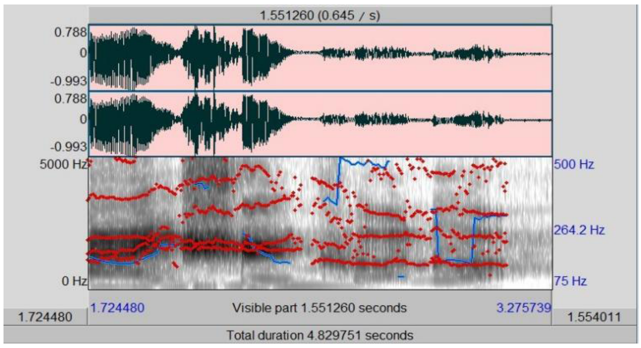

Figure 6. The phonetic analysis of Beijing male speaker.

The Praat analysis of the Xi’an female speaker’s pronunciation of the plagiarized trademark was conducted across five acoustic parameters. The pitch contour appears as fragmented wave-like segments, initially rising and then falling. Analysis of the spectrogram indicates the presence of three vowels, with a noticeable interruption in the waveform corresponding to a brief pause. The average F_0 is 318.25 Hz, and the terminal pitch rises to approximately 470 Hz, indicating an upward intonation at the end of the utterance. The total duration of the pronunciation is 3.58 seconds. Regarding formant frequencies, the F_1 is 783.76 Hz, and the F_2 is 1790.82 Hz, reflecting typical vowel resonance patterns characteristic of the Xi’an dialect while maintaining intelligibility in Standard Mandarin (**Figure 7**).

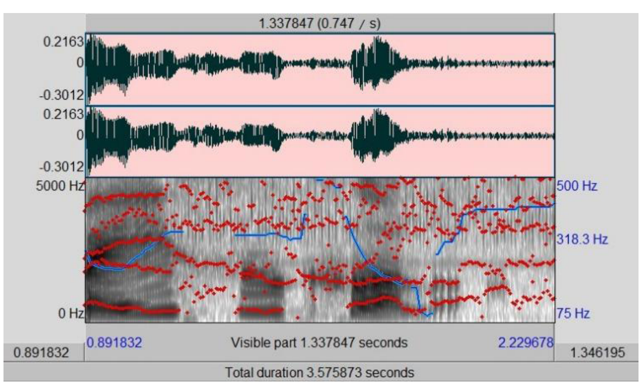

Figure 7. The phonetic analysis of Xi’ an female speaker.

The Praat analysis of the Xi’an male speaker’s pronunciation of the plagiarized trademark reveals a fragmented pitch contour with five discernible intervals. The shape of the pitch line exhibits alternating rises and falls, beginning with a downward movement, followed by an upward inflection, and repeating this pattern, ultimately ending with a rising terminal pitch of approximately 485.2 Hz. The average F_0 is 251.25 Hz, and the total duration of the utterance is 5.43 seconds, making it the longest among the four speakers analyzed. Regarding formant frequencies, F_1 is 1090.27 Hz, and F_2 is 1658.86 Hz, indicating robust vowel resonance with slight lowering compared to the female Xi’an speaker, consistent with male vocal characteristics (**Figure 8**).

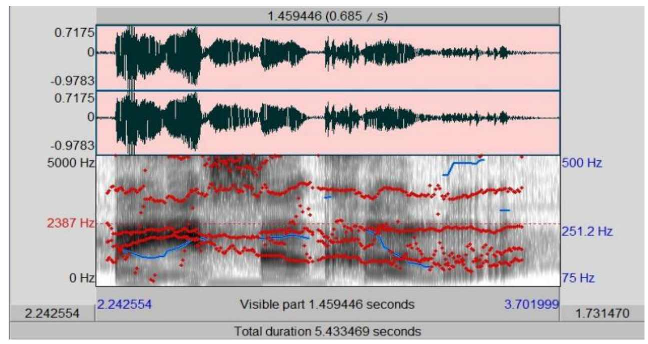

Figure 8. The phonetic analysis of Xi’an male speaker.

4. Pragmatic considerations in trademark perception

Given China’s vast geographical and socio-economic diversity, pragmatic factors play a significant role in how consumers perceive and interpret trademarks. Differences in literacy, education, and exposure to mainstream media contribute to varying levels of brand recognition. In economically disadvantaged towns or rural areas, where literacy rates may be lower, consumers may struggle to distinguish between visually or graphically similar trademarks. In such contexts, even subtle variations in characters or imagery can lead to confusion and potential misidentification of products.

To illustrate this phenomenon, **Figure 9** presents a visual comparison of the original and plagiarized trademarks. The left image depicts the authentic Pepsi brand, while the right image shows the plagiarized version. Both the bottle shapes and overall graphical elements are nearly identical, highlighting how visual similarity can exacerbate pragmatic confusion among consumers who are less familiar with written characters or brand-specific features [16].

Figure 9. Comparison of the trademarks.

5. Conclusion

Based on the phonetic data collected, the pitch contours of each trademark exhibit notable similarity across speakers, with the lines generally appearing fragmented and wave-like. A comparison of the acoustic profiles reveals consistent shapes among all participants; however, gender-specific differences are apparent. For example, the Beijing male speaker consistently produces a deeper pitch compared to the other speakers. Additionally, there is a systematic difference in terminal pitch orientation, where in all cases, the original trademark "Bǎi Shi Cola" concludes at a lower pitch, whereas the plagiarized "Bái Shi Cola" concludes at a higher pitch. The durations of the utterances range approximately from 3 to 5 seconds. When comparing pronunciations of the same speaker across the two trademarks, the durations are nearly identical. For instance, the Beijing male speaker produced both trademarks with a duration of 4.83 seconds, whereas the Beijing female speaker produced "Bǎi Shi Cola" in 3.18 seconds and "Bái Shi Cola" in 3.72 seconds.

From a morphological perspective, all trademarks function as proper nouns in Chinese. In this language, proper nouns do not inflect for singular or plural forms, and their syntactic usage is limited to nominal reference; phrases or modifiers are typically not applied to trademark names. Despite structural similarities, the semantic divergence between the original and plagiarized brands is significant. The original "Bǎi Shi Cola" conveys the positive meaning of "all things can bring happiness," whereas the plagiarized "Bái Shi Cola" carries a morbid connotation, implying that "the death of people is a source of happiness." This semantic contrast underscores the importance of both phonetic and morphological analysis in understanding the perceptual and cultural impact of trademark plagiarism.

Disclosure statement

The author declares no conflict of interest.

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Supporting Algebraic Understanding: A Comparative Study of Secondary School Mathematics Texts

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Abstract

This study examines how algebra is conceptualised within the planned curriculum in England and China, focusing on how teaching materials support the development of algebraic thinking skills. The analysis drew on current teaching resources (Chinese textbooks and English lesson slides) in two nations. The findings revealed distinct pedagogical orientations toward fostering algebraic thinking. In England, the development of abstract thinking is supported through connections to real-world contexts and the use of multiple representations. In contrast, Chinese materials adopt a more formal and abstract approach, emphasising symbolic manipulation. Overall, the findings point to fundamentally different pedagogical traditions in algebraic notation instruction and distinctive approaches to linking arithmetic and algebraic thinking.

Keywords

Algebraic notation; Comparative; Planned curriculum; Textbook analysis; Understanding

Online publication: August 26, 2025

1. Introduction

Towards the end of the 20th century, there was a flourishing of research on textbooks, hardly surprising given the numbers being used around the world. In 1990, Newton noted that in the UK alone, about 30 million school textbooks would be sold to support teaching, learning and curricula. In his book, Teaching with Text, he quoted: "The text is not simply a teaching aid, like a globe, or the models used in geometry lessons. It can be a self-contained teaching unit [1]. He goes on to describe how the textbook, used in a variety of contexts, behaves like a surrogate teacher. Despite the rise of the internet and teachers' access to online materials to support their planning and curriculum delivery, textbooks still seem to have some popularity today. In mathematics education, textbooks are still frequently used to support curriculum planning and pedagogic activity [2]. Some studies have focused on the mathematical content and curricular activities, whereas others have also explored mathematical processing of the problems presented, for example problem solving and mathematical reasoning [3–5].

When such studies make international comparisons between East Asian countries and those in Europe and the USA, the findings can contrast greatly. For example, they found textbooks in East Asia good at conveying ideas but less motivating [6]. Yet in England and the USA, the opposite seemed to hold true. Western textbooks were good at explicit relevance, tying experiences to real life, but less effective at supporting conceptual understanding and the mental connections between the concepts and the real world. Moreover, generic cultural features were noted in some textbooks.

The picture is a complex one, therefore this study aims to investigate the algebra tasks and activities in the textbooks used in two very different education settings (China and England). Furthermore, the literature review revealed a lack of published research on how algebraic notation is introduced in textbooks from East Asian and Western contexts. Accordingly, this study also explores how algebraic notation and understanding are represented in textbooks from England and China.

2. Algebra and algebraic notation

Algebra occupies a central position in mathematics education. Traditionally, algebra has been introduced at the secondary level, typically between the ages of 13 and 15, while arithmetic and number sense have been the focus of primary education. Cai and Knuth argue that this historical divide may explain why many students encounter persistent difficulties when first engaging with algebra [7]. Linchevski and Livneh identified two broad perspectives on the nature of algebra that help clarify this issue [8]. The first regards algebra as a new, formal system, a symbolic language in which letters represent unknowns. As Soneira notes, this symbolic language differs fundamentally from everyday natural language in its structure and meaning, often leading to confusion when students must maintain consistent symbol meanings in contexts that, in ordinary language, would allow for change [9]. In contrast, a second view presents algebra as a natural outgrowth of arithmetic, arising through processes of generalisation and abstraction from numerical and quantitative reasoning [10].

From this standpoint, algebraic understanding develops gradually as learners build on their arithmetic experiences to express and reason about relationships in increasingly general forms. Hackenberg and Lee highlight that algebra involves both recognising general patterns within arithmetic and learning to reason with symbolic notation that stands in place of specific quantities [11].

Drawing on this developmental perspective, as well as the foundational work of Kaput, the present study views the emergence of algebraic reasoning as a continuous process leading from generalised arithmetic thinking to formal symbolic representation [12]. This view provides a conceptual basis for exploring how students encounter and interpret algebraic notation, and how such notation functions as a bridge between intuitive arithmetic reasoning and formal algebraic expression.

3. Research questions

This study was guided by two key research questions:

(1) In what ways do the selected textbooks conceptualise and present the teaching and learning of algebra?

(2) To what extent do differences emerge in the ways examples are used to support algebraic thinking?

4. Methods and materials

4.1. Selection of textbooks and materials

Hodgen et al. indicated that the percentage of lessons where textbooks are the principal basis for instruction is 43% in the UK compared to the international average of 60% [13]. In England, commercial packages with ready-made slides, such as White Rose Maths and Mathematics Mastery, are commonly purchased by schools. Kangaroo Maths was selected as a representative example of widely used online materials in English secondary schools. In China, following the introduction of the Mathematics Curriculum Standards for Compulsory Education (2022 version), textbooks were also revised accordingly. This study analysed the latest edition of Mathematics for Lower Secondary School (Grade 7), published by Zhejiang Education Press. The analysis focused on worked examples provided for learners to support their understanding of algebraic notation in England and China. In England, these often present a problem, work through steps to solve it, and provide the “correct” solution.

In this study, the analysis focuses on worked examples provided for learners to examine algebraic reasoning in England and China. In England, these often present a problem, work through steps to solve it, and provide the "correct" solution. A number of researchers have found them to be effective for problem-solving leading to good learning outcomes in algebra [14].

4.2. Results strategies of approaching algebra

When introducing algebra, English lesson slides employed multiple forms of representation, such as pictorial images, to support the solving of word problems and to introduce key algebraic concepts. The two countries' materials differ notably in their approaches. Chinese textbooks typically introduce algebra through formal symbolic representations, using conventional algebraic notation to express abstract ideas and relationships. For example, when introducing algebraic expressions, **Table 1** shows that the Chinese textbooks present decontextualised phrases in mathematical language, rather than in word problems.

Table 1. Examples for working out algebraic expressions in the Chinese textbook

Expression questions	Answers
(1) Three times minus ;	
(2) The sum of twice and half of ;	
(3) The square of the sum of and ;	
(4) The cube root of .	

In each case, the worked solution provides an abstract, letter-symbolic form, without describing the problem-solving process or steps involved in translating the verbal phrase into algebraic notation. By contrast, the English slides introduce variables and expressions through word problems situations, including real-world problems. This aligns with the findings of Hänze & Leiss, who noted open-ended, real-world situations as a method to inject meaning and serve as authentic problems that might be met in real life [15]. In the process, several symbolic systems like words, tables and graphs are used to support algebraic understanding. For instance, both the higher level and foundational level slides provided pictorial notations (**Figure 1** and **Figure 2**) to support students in constructing meaning, recognising unknowns. Researchers have previously suggested that such multiple representations of algebraic understanding could be developed as a way to help address the difficulty of variables of notation noted at lower secondary levels [16].

In one example from the foundation level slides, students are presented with a story: "Pirate Pete and Paul have been plundering! So, each of them has a bag full of jewels." As shown below, pictorial notation was used: a bag with an unshown number of jewels in it represents the number of jewels each pirate has. The left-hand column shows an image of the result of each step, with the corresponding algebraic expression on the right. The right-hand column shows a word problem followed by its algebraic expression in the step. In order to work out and check all numbers, students must keep in mind a generic amount, the picture of the bag. According to Kaput et al., the bag and jewels notations acts as an icon to simplify at each step [10]. This scaffolds the transition from the pictorial representation to , the algebraic representation.

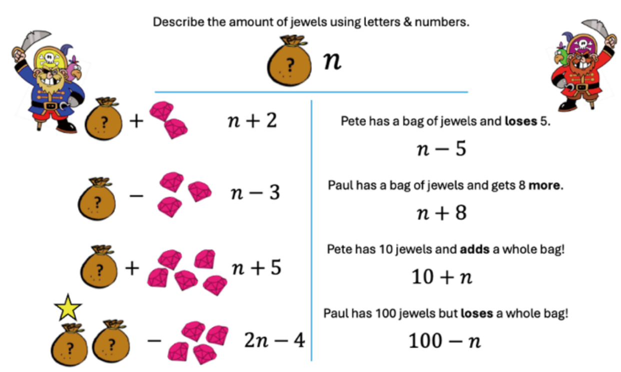

Figure 1. A worked example from the foundation level at phase 1.

Another important difference lies in the use of various contexts for problem situations in England. Contextualised problems are considered appropriate for introducing students to algebra [17]. English textbooks prefer to use story problems as the sources for solutions to problems rather than irrelevant symbols to manipulate. This seems to make it easier to give expression to such mathematical generalisations. In the English slides, a large number of examples are presented in story-problem format. This is thought to support understanding of symbols. They also use natural language terms (e.g. "many") to encourage general expressions (see **Figure 2**). For instance, a higher level example of simplifying a

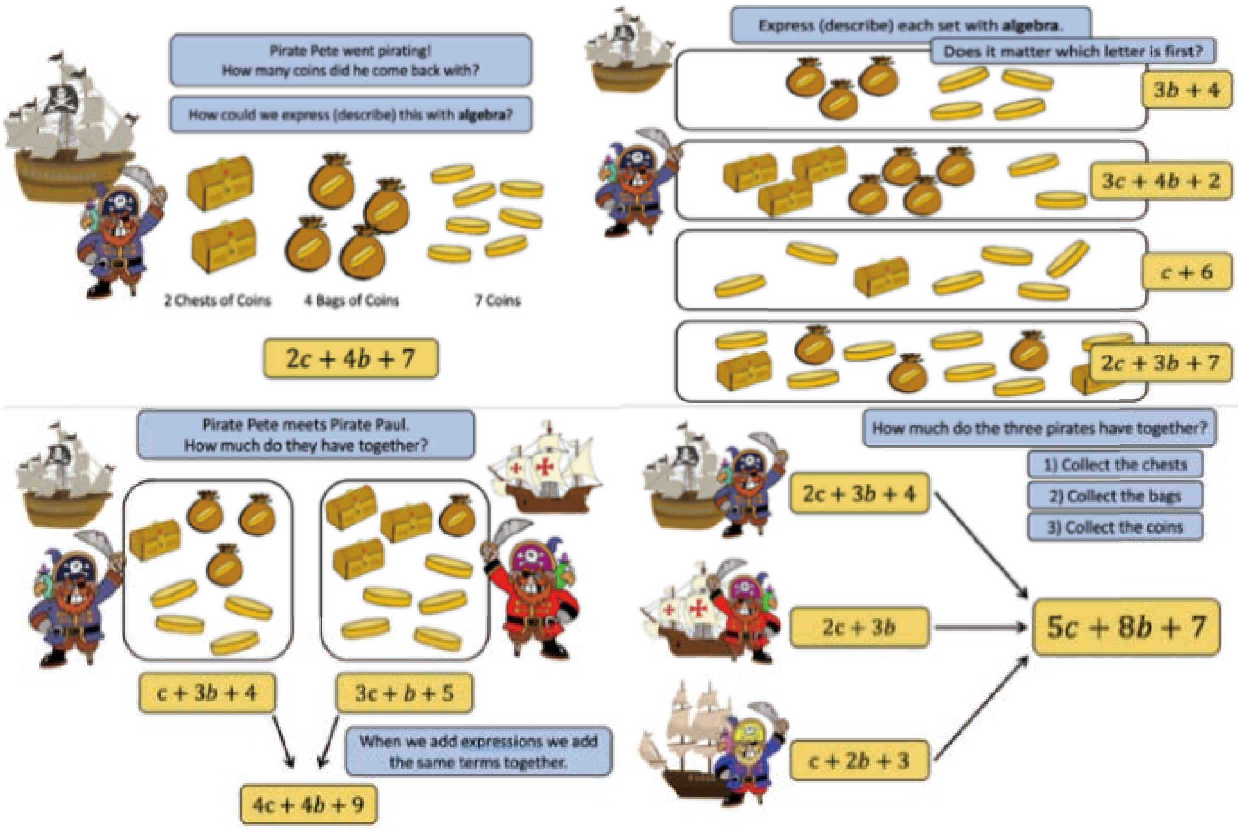

Figure 2. An example of forming the understanding of algebraic notion in England.

simple expression at Grade 7 starts with a story: "Pirate Pete went pirating, how many coins did he come back with? How could we express this with algebra?"

Through this narrative, students are introduced to algebra via a familiar and therefore meaningful real-life context (the problem), where they interact with unknown quantities of chests or bags of coins (the variables), and must assign symbols such as "b" and "c" to represent them. Through such contexts, students also build meaning for the use of algebraic properties and axioms during the manipulative process, such as when asked to collect the like terms.

5. Discussion

5.1. Ways of supporting algebraic understanding

The slides materials from England reveal links with real life contexts and extensively feature graphic representation, while the Chinese textbook provides particular opportunities for symbolisation. In addition, this study confirmed the previously reported tendency for Chinese students to show greater fluency in operations and in taking abstract approaches.

At both foundation and higher level in England, more weight was given to connecting the concept of arithmetic and algebra. The multiple representations (e.g. pictorial, tabular, graphical methods) used in word problems (**Figure 1** & **Figure 2**) reflect the importance placed on the use of algebra in the mathematical modelling of "real-life" contexts in English curricula and materials. In other words, the stress placed on everyday life problems is much greater than in China. These examples in England demonstrate the abstractness process is driven by a desire to assist students in the construction of meaning with relation to understanding.

In each case in these slides, meaning construction is assisted by invoking contexts outside the domain of algebraic manipulation, whilst the nature of that meaning is purposed in various different ways. Such intentions are targeted at helping students not only to reason around the abstractness process but also to form connections between algebra and other aspects of their experience. This process contains strong inductive structure. Therefore, the algebraic understanding in English lesson slides predominantly remains at the level of operational (process-based) understanding of algebraic thinking, whilst the examples in Chinese textbooks increasingly encourage the development of an abstract structural perspective on algebra. However, the overuse of algebraic rules and their level of complexity, combined with the difficulty of problems students face, and the level of algorithms required to manipulate algebraic expressions, may risk students falling into automatic symbolic manipulation without knowing why they do what they do [18].

5.2. Origins of these differences

Underneath the mathematical modelling of "real-life" contexts (e.g. pictorial representation of variables) in England, and the decontextualised and symbolic forms in China, the different approaches reflect contrasting views of pedagogical traditions in the two regions. The Chinese textbooks resembled an abstract, symbolic approach to algebra, placing heavy emphasis on both abstract approach and problem solving. This confirms the structural approach to algebraic understanding in Chinese textbooks.

On the other hand, the English materials stressed the importance of familiar real-world connections, which means solving algebraic problems using methods other than manual symbolic manipulation. This confirms the functional approach in England's materials. This study may suggest that materials provided to teachers in different regions signal how algebraic understanding is defined and developed. This explanation proves additional explanatory power for the different traditional methods or approaches for classrooms in England and China. However, the data from this study are insufficient to draw strong conclusions. Examining teachers' classroom practice might help us understand better how far the historical and cultural traditions of each country are stressed and to what extent the pitfalls of each are addressed.

6. Conclusion

The findings of this study provide several implications for classroom practice and curriculum development. The English materials, with their focus on contextualised and representational approaches, show the importance of providing students with opportunities to make sense of algebraic ideas through real-world situations. Such approaches appear to help learners construct meaning and develop algebraic understanding beyond symbolic manipulation.

Conversely, the Chinese textbooks demonstrate the strength of a more formal and structured progression, which supports students in developing precision, procedural fluency, and an awareness of the logical structure of algebra. However, these two orientations should not be seen as separate entities. Instead, integrating the contextual and structural approaches may offer a more balanced way of supporting students' transition from operational understanding to abstract thinking. Teachers might therefore consider designing classroom activities that combine real-world contexts with explicit attention to algebraic structure, enabling students to move flexibly between the two forms of understanding.

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Strategic Research on the Path Optimization of Ideological and Political Education in Colleges and Universities Empowered by Artificial Intelligence

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Abstract

In recent years, artificial intelligence (AI) technology has experienced rapid development, witnessing the emergence of various cutting-edge tools represented by large language models such as Deepseek, Doubao, and ERNIE Bot. These technological breakthroughs have brought unprecedented opportunities to the concepts, methods, paths, and technical support of Ideological and Political Education (IPE) in colleges and universities. Against the backdrop of the Ministry of Education's "AI Empowers Education Initiative," this study aims to accelerate the digital transformation of education, enhance college teachers' digital teaching capabilities, and deepen the integration of digital technology with classroom teaching. By focusing on the core application scenarios of AI-enabled IPE, this research explores targeted optimization strategies for the development paths of AI-empowered IPE in higher education institutions, with the ultimate goal of improving the practical effectiveness of ideological and political education.

Keywords

Artificial intelligence; Ideological and political education in colleges and universities; Path optimization; Strategies

Online publication: August 26, 2025

1. Introduction

As a core driving force behind the new round of technological revolution and industrial transformation, artificial intelligence has exerted a profound impact on all aspects of human social life. For Ideological and Political Education (IPE) in colleges and universities, AI has unlocked a series of new opportunities, including enhancing teaching interaction and interestingness, providing personalized learning experiences, and enabling precise teaching implementation and rational resource allocation. As a pivotal course for fostering virtue through education, IPE courses must proactively seize these opportunities to achieve innovative development.

On January 19, 2025, *Planning Outline for Building an Educational Power (2024–2035)*, which explicitly states the need to "promote AI to assist educational reform." Ministry of Education's "AI Empowers Education Initiative," this study explores the optimization strategies of AI-enabled IPE paths in colleges and universities, aiming to continuously improve the quality and effectiveness of ideological and political education.

2. Demand analysis for the path optimization of ideological and political education in colleges and universities

2.1. Demand for personalized classroom teaching

With the continuous progress of the times, the growth and learning environment of contemporary college students have undergone profound changes. They are characterized by active thinking and strong self-learning abilities, capable of selecting appropriate learning content and methods based on their own needs and interests. Meanwhile, they can adapt to diverse learning environments and conditions, demonstrating remarkable independent thinking skills. The rapid advancement of AI technology has further expanded the channels for college students to understand the world. The widespread popularity and application of new media platforms such as Weibo, Douyin, and Bilibili have significantly enhanced students' sense of subjectivity and right to speak.

Moreover, each student is an independent individual with unique family backgrounds, growth experiences, and learning abilities, which determines that in addition to the commonalities shared by contemporary college students, there are significant individual differences and personalized needs among them [1]. Therefore, IPE teachers in colleges and universities should recognize these differences and promptly update their teaching strategies and methods to achieve personalized teaching tailored to individual students. However, the current IPE teaching in colleges and universities still faces several prominent problems. In terms of teaching models, large-class teaching is widely adopted, with classes often consisting of over a hundred students. For teachers, it is extremely challenging to implement personalized teaching and pay attention to the individual needs of each student under such circumstances. Regarding teaching content, most IPE courses are confined to textbook knowledge, with insufficient integration of social hot topics and current political events, resulting in a lack of timeliness and vitality.

In terms of teaching methods, theoretical indoctrination remains the dominant approach, leading to a single and rigid teaching form. The combination of large-class teaching, limited teaching content, and monotonous teaching methods inevitably leads to the neglect of students' individual differences as the main body of learning [2].

2.2. Demand for active classroom interaction

The "head-up rate" serves as a crucial indicator to measure the attractiveness, appeal, and impact of IPE courses. How to make each IPE class engaging enough to encourage students to "look up," listen attentively, and actively ask questions is a question that every IPE teacher must deeply reflect on. In recent years, with the continuous reform of IPE teaching, corresponding rules and systems have been established, and the teaching staff has been expanded. As a result, students' enthusiasm for attending classes, head-up rate, and participation have improved compared with the past. However, there are still obvious deficiencies in teacher-student interaction and classroom atmosphere.

One typical issue is the "scripture-reciting style" of teaching: some teachers simply read the courseware verbatim in class, avoiding students' confusion and questions. In their view, as long as the basic teaching tasks are completed without teaching accidents, their work is done. The tedious content and flat, monotonous tone have led to a growing number of "phubbers" in IPE classes. Another problem is "performance-style" interaction: although it is commendable that IPE teaching has made many innovations in form, some of these innovations are ineffective. For example, some teachers pre-determine classroom themes, ask students to form groups freely after class to prepare presentations around the themes, and then devote most of the class time to student group displays and situational performances. This approach pushes students to the forefront while the teacher remains in the background. While this teaching form may help students conduct independent exploration and free thinking to a certain extent, it can easily make classroom teaching a mere formality if not properly controlled.

Additionally, the "cramming-style" indoctrination still persists: sometimes teachers speak passionately on the podium, while students remain indifferent, with no effective communication or interaction between them. Students' participation is extremely low, and their initiative as the main body of learning is not fully mobilized, resulting in a negative classroom atmosphere and a significant reduction in the effectiveness of IPE.

2.3. Demand for diversified course evaluation

IPE teaching evaluation is not only an important means to implement national educational policies but also a key tool for teachers to understand teaching effects, adjust teaching strategies in a timely manner, and improve classroom teaching quality. For students, scientific and effective evaluation can not only assess their learning outcomes but also motivate them to actively participate in learning activities, fostering good learning habits and a positive learning attitude. The evaluation methods for teachers in college IPE courses are relatively diversified, mainly including student evaluation, peer evaluation, supervisor evaluation, and teacher self-evaluation.

As one of the main evaluation subjects, students usually conduct a comprehensive evaluation of teachers in terms of appearance, teaching demeanor, teaching content, teaching methods, language expression, and blackboard writing. Peer evaluation involves experts in the same field evaluating teachers' teaching content, methods, classroom organization, and teaching effects through classroom observations. Supervisor evaluation refers to teaching supervisors conducting professional and comprehensive evaluations of teachers' preparation of teaching content, application of teaching methods, and classroom management. These evaluation methods help teachers understand their strengths and weaknesses in teaching, obtain timely feedback and suggestions, and further improve their teaching level.

However, the current evaluation methods for students in some college IPE courses are relatively single, mainly adopting summative evaluation through final exams and course papers. This approach neglects the evaluation of intangible and difficult-to-quantify content such as students' values and critical thinking abilities. In addition, the evaluation criteria are uniform for students of different grades and majors, lacking the evaluation of students' dynamic performance in the learning process and failing to reflect the particularity of IPE in "fostering virtue through education."

3. Research on specific application scenarios and strategies of AI technology in the paths of college IPE

The paths of college IPE are diversified and require the integration of contemporary characteristics, student needs, and educational goals through multi-dimensional and multi-level forms. Currently, the main paths of college IPE include curriculum teaching, practical education, network and new media, campus cultural infiltration, and home-school collaborative education. In the AI era, how to innovatively apply new technologies and carriers to the diverse paths of college IPE, enhance the attractiveness of IPE courses, realize the transformation from "indoctrination" to "infiltration" and from "single-dimensional" to "three-dimensional," and truly achieve the goal of fostering virtue through education is a critical issue that every college IPE practitioner must deeply explore.

3.1. Optimization of curriculum teaching paths

The establishment of personalized electronic student files is essential. Compared with traditional IPE, AI-empowered IPE in colleges and universities can establish "electronic student files" for each student based on their actual situation. In compliance with relevant regulations, multi-source data collection can be carried out, including learning behavior data, campus activity data, psychological and emotional data, etc. These data can be used to formulate personalized learning plans for each student, promoting the transformation of traditional large-scale undifferentiated IPE towards differentiated and personalized education, which is conducive to improving the pertinence and effectiveness of college IPE.

On top of that, an intelligent teaching platform should be built as AI-empowered IPE enables the co-construction and sharing of high-quality learning resources, providing convenient channels and platforms for teachers and students to access IPE resources. For example, teachers can upload high-quality courseware, learning materials, and excellent IPE courses to the platform for students to download and learn anytime and anywhere. Meanwhile, with the help of the "AI Teaching Assistant" system, personalized course recommendations can be made based on the data in the "electronic student files," ensuring that students can access learning resources that match their interests and learning needs. Students can also interact with teachers in real time through the intelligent teaching platform to discuss academic issues and solve learning puzzles.

By using virtual simulation technology to restore important historical events, social scenarios, and practical work scenes, students can be placed in an "immersive" learning environment to deeply understand and internalize IPE theories. This not only enhances the interestingness and interactivity of teaching but also helps students establish a more intuitive and profound understanding of abstract ideological and political theories, thereby improving the overall teaching effect [3].

3.2. Optimization of practical education paths

The learning of college IPE is not only confined to the theoretical level but also emphasizes practical experience and internalization. AI-empowered practical education in college IPE can deeply integrate theoretical teaching with practical experience through advanced technical means, significantly enhancing students' sense of participation, interaction, and value recognition. The optimization of practical education paths can be realized through data-driven personalized design:

(1) Conduct behavior analysis and activity adaptation: by analyzing students' daily practical behavior data, such as their decision-making in virtual scenarios, participation in offline social practice activities, and performance in group tasks, AI technology can accurately identify each student's strengths, interests, and areas for improvement, and generate personalized practical tasks that match their characteristics;

(2) Realize cross-regional collaborative practice through technical support: with the help of AI technology, students from different regions, universities, or majors can be matched to form cross-regional practical groups to jointly complete research projects or social practice tasks. AI can automatically integrate the data and results generated during the practice process, assist in sorting out research ideas, and generate professional analysis reports, improving the efficiency and quality of collaborative practice;

(3) Carry out virtual social practice when necessary: considering factors such as the large number of students, safety risks of off-campus activities, and limited practical resources, when it is impossible to organize on-site practical investigations, AI technology can be used to carry out virtual social practice activities. For example, create a virtual city scene to carry out red culture experience activities, such as the "Digital Long March" virtual practice project. By using virtual reality (VR) and augmented reality (AR) technologies, a highly immersive learning environment can be created, making students feel as if they are personally on the Long March, experiencing the arduous journey of the Red Army soldiers and deeply perceiving their revolutionary spirit and lofty beliefs [4].

3.3. Optimization of network IPE paths

In the context of the widespread popularization of the internet, network IPE has become an important part of college IPE. AI technology can significantly enhance the attractiveness, precision, and effectiveness of network IPE through data analysis, personalized recommendation, and intelligent interaction. For instance:

(1) Implement personalized content recommendation: by analyzing students' online learning behaviors, such as browsing records, interaction preferences, search keywords, and knowledge weaknesses, AI technology can accurately grasp each student's interest points and learning needs. Combined with the core goals of IPE, it can recommend targeted course videos, academic articles, typical cases, and practical activities. For example, based on the interests of the students, recommend high-quality documentaries, virtual red venue visit resources, and online lectures by experts; for students concerned about social hot topics, push relevant policy interpretations and value guidance articles;

(2) Conduct real-time monitoring and intervention: after class, AI technology can track and analyze students' online learning data, such as login frequency, video viewing duration, completion of after-class exercises, and test scores. Through data mining and analysis, it can identify students with insufficient learning motivation, passive learning attitudes, or potential deviations in values, and promptly feed back this information to teachers. Teachers can then conduct targeted conversations, psychological counseling, or value guidance for these students, realizing real-time monitoring and positive intervention of students' ideological dynamics;

(3) Optimize homework evaluation and feedback: for open-text assignments submitted by students after network IPE courses, such as learning experiences, research reports, and ideological reflections, teachers can use AI-related technologies (such as natural language processing and semantic analysis) to conduct auxiliary evaluation [5].

AI can automatically assess the logic, depth, and value tendency of students' expressions, identify potential problems in their ideological understanding, and generate personalized and targeted evaluation comments. This not only reduces the workload of teachers in correcting assignments but also ensures the timeliness and professionalism of feedback, helping students promptly improve their understanding and cognitive level [6].

3.4. Optimization of teacher team building paths

Teachers are the direct implementers of college IPE, the promoters of educational reform and innovation, and the guides of students' ideological development. The overall quality of the teacher team is directly related to the quality and effect of college IPE. Building a high-quality IPE teacher team is a long-term and arduous task. Traditional teacher training methods mainly include centralized offline training, the "mentor-apprentice" model of "old teachers guiding new teachers," regular teaching and research activities, off-campus further study or visits, and academic conference exchanges. While these methods have certain effects, their efficiency and pertinence are relatively limited compared with AI-enabled teacher team building.

The application of AI technology in the path of teacher team building can be carried out in the following aspects:

(1) Realize personalized teacher training, where teachers can record their daily classroom teaching videos and upload them to the AI analysis platform. AI can conduct in-depth analysis of the videos from multiple dimensions, such as teaching language, classroom organization, interaction design, and teaching effect, and provide targeted teaching optimization suggestions. At the same time, AI can evaluate teachers' research shortcomings and professional development needs by analyzing their research achievements, published papers, and project application experiences, and recommend personalized training courses and learning resources to help teachers make up for their weaknesses and improve their comprehensive quality;

(2) Provide research and teaching assistance, for the heavy and tedious research work, teachers can use AI technology to conduct literature retrieval, data collection and analysis, thesis writing, and project application. AI can quickly screen relevant literature resources, sort out research trends, and assist in formulating research frameworks, significantly improving research efficiency. For repetitive teaching work, such as correcting homework, organizing test papers, and analyzing student feedback, teachers can use AI technology to realize intelligent processing, reducing their daily workload and allowing them to focus more on teaching innovation and student guidance;

(3) Conduct objective assessment and development evaluation, where AI technology can integrate multi-dimensional data such as teachers' teaching effect evaluation results, student satisfaction, research achievements, and participation in social practice activities, and generate comprehensive and objective teacher evaluation reports [7].

These reports can provide scientific and reliable reference for year-end assessments, professional title evaluations, and promotion of teachers, ensuring the fairness and impartiality of the evaluation process and motivating teachers to continuously improve their teaching and research capabilities [8,9].

4. Conclusion

AI technology has brought an all-round transformation from concepts to practices for IPE in colleges and universities. Its in-depth application in college IPE has realized multiple innovations: on the student side, through personalized learning plans, intelligent monitoring, timely and effective feedback, and immersive learning experiences, IPE has become more in line with students' cognitive characteristics and learning habits, effectively enhancing students' sense of identity and participation; on the teacher side, through personalized training, research and teaching assistance, and objective assessment and evaluation, AI has significantly improved the efficiency and quality of teachers' work, enabling them to better play their roles in IPE. Overall, the application of AI technology has effectively enhanced the timeliness, intelligence, and pertinence of college IPE development. However, it is crucial to emphasize that technology is only a means to achieve educational goals. The core purpose of applying AI in IPE is to better serve teachers' teaching and students' learning, not to replace human beings. Therefore, in the process of promoting AI-empowered IPE, we must avoid over-reliance on technology, adhere to the people-oriented educational concept, and give full play to the leading role of teachers and the main role of students. In the future, with the continuous advancement of AI technology and its in-depth integration with IPE, "precision ideological and political education" and "intelligent ideological and political education" will be further realized, providing a more innovative and effective path for colleges and universities to implement the fundamental task of "fostering virtue through education."

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The Integration Path and Countermeasures Research of Generative Artificial Intelligence and Ideological and Political Education in Higher Education

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Abstract

The integration of generative artificial intelligence (AI) into college ideological and political education helps enhance the precision of value guidance and the penetration of communication, expand the boundaries of educational interaction, and alleviate the structural problem of resource distribution inequality. However, its involvement also brings deep risks such as the weakening of emotional warmth, the blurring of value stances, and the restructuring of educational relationships. It is necessary to be vigilant about the tension between technological rationality and ideological rationality. Colleges should promote the coordinated coexistence of technology integration and value orientation by building an emotional mechanism of human-machine collaboration, establishing a multi-level content generation review system, and reshaping the teacher's leading role.

Keywords

Human-machine collaboration; Ideological and political education in higher education; Generative artificial intelligence; Value guidance

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1. Introduction

The rapid advancement of generative artificial intelligence (AI) is reshaping the fundamental mechanisms of knowledge production and dissemination. In the context of higher education, this technology is not merely an intervention in the methods of teaching content but also, in some sense, undermines the foundations of existing educational philosophies and communication logic. Especially in the field of ideological and political education, which is highly value-oriented, the impact of generative AI can touch upon the technical update of communication methods, as well as the shaping of ideology, the transmission of values, and the redefinition of the roles of teachers and students. The cognitive styles and value orientations of young students are also undergoing profound changes, which may not always be apparent, but their impact on traditional teaching methods is already beginning to manifest. With the updating of digital media, mainstream value expression is under pressure to undergo a discourse transformation. In this complex context, generative AI, with its speed of content output, its human-like expression, and its ability to adapt to input contexts, opens up new operational spaces for ideological and political education in universities.

2. The value of generative AI embedded in ideological and political education in higher education

In the new era, generative AI is intervening in higher education's ideological and political teaching in an unavoidable way. It not only changes the technical means of knowledge transmission but also, to some extent, reconstructs the value expression of the classroom.

2.1. Technological empowerment of value guidance, strengthening the orientation of ideological and political education

The process of embedding generative AI into ideological and political education in higher education is essentially a reorganization of the value logic, not merely an improvement in technical efficiency. From the perspective of ideological education, this intervention involves the algorithmic structure and language simulation methods in the expression of value itself, challenging and reconstructing the original value transmission mechanism.

In the education of red culture and mainstream ideology content, the adjustment of discourse style, contextual adaptation, and audience preferences by AI can make the spread faster and wider, and also make the value guidance more sticky, more perceptible, and internalizable. This means that education no longer relies on a single authoritative discourse output but attempts to reaffirm its legitimacy and appeal in a technological context. In this process, technology is not just a channel, but also involved in the regulation of the value ontology. The corpus selection, expression templates, and semantic connections of the generative mechanism subtly guide the boundaries of value judgment. This reconstruction allows ideological and political education to gradually move away from the traditional form of emphasizing uniform expression and external discipline, towards a more penetrating and more difficult-to-avoid value contradiction interaction process.

2.2. Innovative educational interaction models, aligning with the cognitive characteristics of young students

As generative AI gradually intervenes in higher education ideological and political education, the changes it brings to the interaction model touch upon the shift in value generation and recognition mechanisms. The original structure of teacher instruction and student reception, which was unidirectional, is being replaced by a more participatory and contextualized expression logic. Students' cognitive preferences, whether image-based, contextualized, or fragmented interaction structures, also influence their perception and judgment of value issues.

In this sense, the effectiveness of traditional ideological and political discourse is beginning to weaken, while the conversational expression and dynamic context provided by generative AI constitute a new technological channel for re-engaging in value education. If the language rhythm, emotional cues, and logical paths of AI can be internalized by students as part of their self-judgment, then the goal of education is not only to transmit but also to stimulate. Value recognition often occurs in this ambiguous and complex participatory process. It can be said that while AI does not change the essence of education, it can re-activate the mechanisms of how value touches the subject and how it is actively constructed.

2.3. Promoting educational resource equity, breaking the spatiotemporal barriers of ideological and political education

The integration of generative AI into higher education ideological and political education can be understood as a deep disruption of the logic of educational resource allocation. For a long time, some universities with rich faculty and regional advantages have occupied the center of the discourse in ideological and political education, while students in remote areas or those who are mobile often find themselves on the periphery of value education. This imbalance is not always due to improper institutional settings but often stems from the natural limitations of physical and temporal constraints on the dissemination of educational resources.

The introduction of generative artificial intelligence breaks some of the value barriers determined by the field. Through intelligent question-answering, virtual interactions, and contextual simulation, education begins to move away from the closed structure of the classroom toward a more flexible response mechanism. Moreover, what technology can achieve is not replication, but the reconstruction of value expression paths through the detailed identification of student contexts and needs. This change not only enhances accessibility but also redefines what constitutes "effective" supply. In this sense, higher education achieves a re-negotiation of the right to value resonance.

3. Challenges of embedding generative AI in college ideological and political education

While acknowledging the positive potential of generative AI, it is necessary to remain vigilant about the structural issues exposed by its involvement in college ideological and political education. Technology not only expands boundaries but also introduces certain overlooked deviations. The boundaries of technology use need to be redefined, and the ways of human-machine collaboration also urgently need to be re-established.

3.1. Risk of technological alienation: Weakening the emotional temperature of ideological education

As generative AI gradually embeds into college ideological and political education, there is a risk that the emotional structure of education may be eroded by the logic of technology. Ideological education is not merely about conveying concepts; it largely depends on a relational network built on trust and empathy. This network is not easily simulated by algorithms; its meaning often lies in the words, tone, and even the pauses or eye contact of the teacher. When technology begins to replace human involvement in dialogue, text responses, and other scenarios, the mechanisms of interpersonal warmth and emotional feedback in the educational context begin to loosen.

While human-machine interaction is more efficient in information response and logical presentation, it cannot mask the inherent deficiency of AI in emotional perception. Students who are accustomed to this "algorithmic response" may gradually become accustomed to a flattened sense of care, losing the emotional mobilization needed for ideological education, which is a crucial prerequisite for value recognition. The issue is not whether technology is cold, but whether the emotional experience in the educational process can still maintain its "awakening" after being converted into parameters. If the logic of technology spreads without resistance, ideological education may quietly deviate from its educational purpose, leaving only programmed indoctrination.

3.2. Value infiltration dilemma: Guarding against algorithmic bias and value conflict

The introduction of generative AI into higher education ideological and political education brings with it value assumptions that are difficult to fully control or identify. On the surface, AI appears to be a neutral production tool, but this neutrality is constructed rather than natural. The design of algorithm models, the orientation of training data, and the choice of which information is encoded and which tone is prioritized are already embedded in the generation process with a biased logic. This bias often appears in the form of "rational" or "natural," making it difficult to identify at first glance. In topics of high value density, such as historical evaluation, social morality, or ideological boundaries, generated text is often prone to sliding into a Western liberal narrative framework. This "default acceptance" is often hidden in the use of certain sentence structures. This leads to the weakening or marginalization of collectivism, national memory, and other local values. If this subtle shift is not identified and directly embedded in the teaching process, it will interfere with students' identification and trust in mainstream values.

3.3. Education subject ambiguity: The challenge of reconstructing the role positioning of teachers and students

The increasing infiltration of generative AI in higher education ideological and political education has led to a blurring and shifting of the originally clear division of teacher and student roles. Teachers, who have long been the authoritative figures in value guidance and knowledge explanation, maintain a symbolic support in the teaching relationship, though their status is not absolute. Students, on the other hand, typically complete the process of understanding through interaction and guidance. This structure has maintained a basic responsibility and trust order in education for a long time.

However, when AI can generate teaching texts, simulate interactions, and provide feedback, the authority of teachers, which was built upon experience and judgment, is gradually diluted. Students often no longer rely on teachers to elaborate on concepts, but instead seek answers directly from the conclusions provided by algorithms. This solves the problems in learning, but skips the thinking process. Over time, patience and the ability to question complex issues diminish, and teachers may retreat to the role of system operators or content reviewers.

4. Optimization strategies for the integration of generative AI into higher education ideological and political education

Based on the multiple driving factors brought by technological empowerment, higher education ideological and political education should focus on building a human-machine collaborative educational community. This process requires continuous harmonization between technical rationality and value rationality, so that the functional integration of intelligent tools can truly be embedded into educational goals.

4.1. Strengthening humanistic care and building a "human-machine collaboration" emotional interaction model

In constructing a "human-machine collaboration" emotional interaction mechanism in higher education ideological and political education, the first practical step is to institutionalize the application scope of AI. Schools should establish a special approval process, requiring teachers to clearly list the specific stages of AI involvement, functional boundaries, and tasks that must be completed by human guidance during the course application phase. This system should not only be used for pre-approval but also included in mid-term inspections and course quality assessments. Supervisory groups should regularly review the actual implementation of AI-involved sections. Operationally, when dealing with major historical events or emotional topics (such as collective honor, sacrifice, and dedication), teachers should primarily use manual explanations, with AI only providing discussion materials, contextual supplements, and not outputting value-judgmental conclusions.

It is also necessary to promote the development of AI plug-ins tailored to the context of higher education, focusing on semantic and emotional recognition. The system should classify and provide real-time feedback on emotional-sensitive words or ideological-related statements in student inputs, assisting teachers in understanding student psychological reactions and adjusting teaching strategies. In classroom organization, teachers should actively set "emotional triggers," with AI generating guiding materials, such as reconstructing the "May 4th Spirit" in first-person narratives from a student's perspective, followed by teacher-led value discussions, rather than having AI directly provide definitions or summaries. The generation of such materials should be based on pre-set templates. Teachers and technical personnel can collaboratively develop templates that meet ideological and linguistic appeal requirements, calibrating AI generation styles.

To ensure the effective operation of the human-machine collaboration mechanism, a multi-point intervention system involving course management, AI material optimization, and classroom organization methods should be established, creating a dynamic structure with teachers as the guiding core, AI as the expression extension, and students as the responding. The key to this structure is not to enhance AI functionality itself but to embed its output effectively into the emotional education chain, ensuring that its technical attributes do not interfere with the value transmission and emotional generation of higher education ideological and political education.

4.2. Establishing a content review mechanism to strengthen the ideological security defense line

Introducing generative AI into the context of ideological and political education in higher education necessitates placing content security at the forefront of operational processes. Specifically, the review mechanism should be embedded throughout the entire generation process, from pre-input restrictions, during generation, to post-output tracing, forming a closed-loop review system that combines technology and institutional coordination. At the input stage, schools should establish unified standardized invocation protocols, clearly defining the sources of materials, instruction structures, and usage permissions. Any content involving history of the Party, national history, institutional comparisons, or current political topics should be prohibited from open instruction generation, and only pre-approved script templates should be used to avoid misinterpretations of ideological deviations in ambiguous instructions. Technical teams can develop instruction input controllers based on existing teaching platforms, implementing real-time (October 20, 2025) regulation and setting usage permission levels, limiting content depth and granularity.

In the output stage, the review process must be pre-positioned at the generation node, establishing a human-machine collaborative review mechanism. It is recommended to form a cross-functional team comprising ideological and political course teachers, technical personnel, and network risk analysis specialists. They should develop embedded semantic review plugins to identify value orientation and historical narrative compliance. If historical nihilism, political neutrality, or other preset ideological expressions appear, the system should immediately block and prompt manual review. The core of this mechanism is not filtering but training AI to form stable expression boundaries. Therefore, a "ideological risk case library" should be systematically built based on issues exposed during the generation process, serving as negative sample reverse training materials to continuously refine the model's output behavior in edge contexts.

For post-output supervision, relying solely on post-event spot checks is insufficient. A more stable approach is to bind AI-generated records with course IDs, teacher identities, and platform usage scenarios to enable traceable accountability. If content leaks or misinterpretations occur, responsibility nodes can be quickly identified. Additionally, for multi-platform AI tool usage, schools should establish unified interface gateways, requiring all ideological content to undergo secondary verification through the school's ideological platform. Technically, the ideological and political teaching team should directly participate in corpus construction and model parameter fine-tuning, inputting content with clear ideological orientation into the training set to enhance the model's stability and political consistency in the context of higher education ideological and political education. Through the operation of input control, process supervision, and model optimization, a verifiable and dynamically adjustable security mechanism can be constructed, ensuring that AI maintains appropriate boundaries and directionality in ideological and political education, rather than becoming a narrative subject detached from regulation.

4.3. Reshaping the roles of teachers and students, promoting the integration of "technological empowerment + value guidance"

In the process of generative AI gradually embedding into higher education ideological and political teaching, the boundaries of responsibilities between ideological and political teachers and students must be redefined through specific institutional operations to ensure that the process of technological empowerment does not deviate from the basic logic of value guidance. In practice, universities can formulate a "main control list for AI use in ideological and political courses," clearly listing teaching tasks that must be independently completed by teachers, including the setting of value positions, guiding controversial issues, and clarifying ideological boundaries. All tasks involving political judgment and emotional guidance must be directly handled by teachers and cannot be delegated to the technical system. AI can only intervene in auxiliary tasks such as scenario construction, case material integration, or language expression refinement. During the operation, a review mechanism should be established to track the usage frequency and intervention depth of generated content, preventing AI from unconsciously replacing the cognitive dominance of teachers.

In terms of teaching interaction, dialogue chains can be designed around typical value tension points, forming a rhythm of "teacher sets the question, AI generates opposing text, students respond and analyze, and the teacher summarizes and guides." For example, around the topic of "the influence of the Party's history on the value construction of contemporary university students," teachers can design value-oriented questions, AI can simulate opposing viewpoints, students can analyze logical flaws or ideological tendencies, and the teacher can guide the summary of political value implications, maintaining the controllable framework of human judgment. To prevent students from developing repetitive expression or thinking inertia due to excessive reliance on AI materials, teaching platforms need to embed evaluation plugins, establish three-dimensional indicators such as ideological depth, clarity of stance, and original expression, and conduct structured assessments of student responses, especially in terms of value reasoning complexity, to enhance their ability to identify and respond to AI-generated discourse.

5. Conclusion

The integration of generative AI into higher education ideological and political education is not merely a tool replacement, but an inadvertent change in the presentation of values and a reshaping of the interaction process in education. In the context of continuous technological advancement, the fundamental demands of higher education ideological and political education, especially its humanistic and value-oriented aspects, are facing the risk of being guided or even reprogrammed by technological logic. This change may not be immediately perceptible, but it is accumulating structural consequences. In the future, the development of ideological and political education should not rely on a fixed configuration, but should explore operational methods that must remain vigilant between modern technology application and value adherence.

Disclosure statement

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Exploring Transformation of AI-Empowered Teaching Models in Higher Education: A Case Study of New Energy Science and Engineering

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Abstract

Against the backdrop of the global digital transformation in education and the deep integration of artificial intelligence (AI) technology, AI-empowered higher education has become a significant trend in international educational reform. Based on the demands of global energy transition and industrial transformation, this paper focuses on the interdisciplinary field of New Energy Science and Engineering, systematically reviewing the international research context, current developments, and practical challenges of AI-empowered teaching. Taking the "Hydrogen Energy and Fuel Cell Technology" course as an example, a teaching reform path centered on "value integration, environment reconfiguration, and role transformation" is proposed. By promoting systematic innovation in teaching philosophy, learning environment, and the roles of teachers and students, this study explores the construction of a human-centered, human-machine collaborative educational paradigm, providing theoretical reference and practical cases for the digital development and teaching model transformation of global higher education.

Keywords

Artificial intelligence; Human-machine collaboration; New energy science and engineering; Teaching model; Teaching reform

Online publication: August 26, 2025

1. Introduction

In recent years, the application of artificial intelligence (AI) technology in the global education sector has continuously deepened, becoming a significant force in promoting educational modernization and digital transformation [1]. International organizations such as UNESCO and the World Economic Forum have repeatedly emphasized that emerging technologies, represented by AI, are reshaping the landscape of higher education and fostering fundamental changes in teaching paradigms [2]. Against this backdrop, many countries have incorporated AI in education into their national strategies, aiming to build more personalized, ubiquitous, and intelligent educational ecosystems [3].

As a key interdisciplinary field addressing global climate change and promoting the transformation of energy structures, New Energy Science and Engineering is characterized by rapid knowledge iteration and strong practical demands, which pose new challenges to traditional teaching models [4]. Leveraging its advantages in adaptive learning, simulation, data insight, and intelligent assessment, AI technology has opened new pathways for cultivating high-quality talents with cross-disciplinary expertise in "Energy + AI" [5]. However, the integration of AI and education globally remains in a phase of exploration and refinement, facing multiple challenges such as insufficient conceptual alignment, outdated teaching methods, a mismatch in digital literacy between teachers and students, and inadequate technological integration environments [6]. Therefore, this paper aims to systematically review current international research progress and practical difficulties, using a specific course as a practical vehicle to construct a scalable AI-empowered teaching model framework, providing an internationally informed reference for teaching reform in related disciplines.

2. Research review and practical challenges of AI-empowered teaching

2.1. Research background: Dual drivers of global education reform and professional development

From a global trend perspective, promoting the deep integration of AI and education has become an important strategy for many countries to enhance education quality and foster educational equity [7]. Cao *et al.* pointed out that the rapid development of artificial intelligence is driving the digital transformation of teaching, and its potential in personalized teaching is increasingly being recognized [8]. In the assessment of digital education's impact, Kingsley et al. analyzed its potential obstacles, challenges, and opportunities, thereby highlighting its significance for sustainable education and practices [9].

From the perspective of professional development needs, the global new energy industry is rapidly evolving towards digitalization and intelligence, with AI applications becoming increasingly widespread in areas such as energy demand forecasting, grid optimization, fault diagnosis, and operation maintenance [10,11]. This necessitates that talent cultivation in the new energy field keeps pace with technological advancements, integrating AI thinking and skills into the curriculum system to equip students for future energy systems characterized by data-driven and intelligent decision-making. Against this backdrop, the specific demands for AI-empowered teaching are reflected in: enhancing the precision and personalization of the teaching process; adapting to rapid technological iterations in the industry; cultivating interdisciplinary composite talents; and driving the continuous innovation and structural optimization of the education system itself [12,13].

2.2. Domestic and international practices and integration challenges

Leading universities domestically and internationally have made significant progress in the field of AI-empowered teaching. For example, Stanford University offers interdisciplinary courses in "AI + Energy," using virtual laboratories to allow students to design and optimize renewable energy systems; Tsinghua University has established a smart teaching platform that enables personalized learning path recommendations and intelligent assessment; RWTH Aachen University in Germany applies AR/VR technology to energy engineering practical training, significantly enhancing students' practical abilities. These practices have effectively promoted educational equity and resource sharing. However, deep-level integration still faces four major challenges:

(1) A contradiction exists between the traditional large-scale, standardized teaching philosophy and the demand for personalized, precise development supported by AI. Many teachers still view AI as an auxiliary tool rather than a driver of teaching paradigm transformation, failing to fundamentally reconstruct teaching objectives and evaluation systems. Balancing the "rationality" of technological tools with the essential value of education in "cultivating people," and avoiding the pitfall of "data-centric bias," is a primary challenge;

(2) Traditional teaching modes is confined by fixed time and space and uniform content, struggling

to meet students' needs for dynamic, vast, and personalized knowledge. Although online forms like MOOCs and micro-lectures partially break through spatiotemporal limitations, knowledge transfer remains largely one-way indoctrination. While AI technology can break spatiotemporal constraints, how to organically integrate it with traditional classrooms to form a blended teaching approach with online-offline interaction, achieving the organic combination of knowledge internalization and ability development, still requires in-depth exploration;

(3) As AI can undertake tasks such as knowledge impartation and homework grading, the role of teachers must inevitably transform. Teachers need to transition from "knowledge authorities" to designers, guides, and motivators of student learning, which places higher demands on their innovative thinking, critical thinking, and human-machine collaboration skills. Currently, university teachers generally lack AI literacy training, often feeling at a loss when faced with intelligent teaching environments;

(4) The existing physical teaching environment is ill-equipped to support the immersive, interactive, and contextualized learning advocated by AI technology. Most classrooms still primarily feature fixed layouts with a podium and desks, lacking infrastructure such as smart terminals, sensing equipment, and high-speed networks. Constructing an intelligent teaching environment that enables virtual-real integration and supports embodied cognition is fundamental to ensuring the implementation of new models.

3. Research approach, content, and methodology: Constructing systemic reform framework for AI empowerment

3.1. Research approach

This study takes the innovation of talent cultivation models in higher education under the background of artificial intelligence as its macro-direction, and uses the core course "Hydrogen Energy and Fuel Cell Technology" in the New Energy Science and Engineering major as its micro-level practical vehicle. The course content covers three key technical chains: "hydrogen production, hydrogen storage, and hydrogen utilization," characterized by its theoretical depth, strong practical focus, interdisciplinary nature, and rapid technological updates. This research intends to carry out systematic and refined AI-empowered teaching reform through three dimensions: exploring an intelligent educational model for the teaching philosophy, making diversified and continuous improvements to the learning environment, and enhancing individual faculty capacity.

This research follows the pathway of "problem-oriented-theory-building-practical validation-iterative optimization." It begins with an in-depth analysis of the practical challenges faced in the teaching of the New Energy major. Subsequently, based on constructivist learning theory, embodied cognition theory, and human-machine collaboration theory, a framework for an AI-empowered teaching model is constructed. This is followed by validating the effectiveness of the framework through course implementation, and finally, engaging in continuous optimization based on practical feedback. This approach ensures a close integration of theoretical innovation and practical exploration, enabling the study to both grasp the macro-level direction of educational reform and address specific teaching problems at the micro level.

3.2. Refined design of research content and methodology

3.2.1. Maintaining educational logic of value integration: Forming an AI-empowered teaching philosophy

To establish a teaching perspective that unifies the instrumental rationality of technological tools with the value rationality of engineering literacy within the comprehensive knowledge system of the "hydrogen production-hydrogen storage-hydrogen utilization" chain. It is essential to fully leverage the instrumental value of AI technology in enhancing teaching efficiency and expanding educational boundaries, while steadfastly adhering to the value pursuits of engineering education in cultivating innovative spirit, practical ability, and social responsibility. The specific pathways and methods are as follows:

(1) Deconstruction of course objectives and content: Conduct a detailed analysis of the three main course modules, as shown in **Figure 1**;

(i) Hydrogen production technology module: the educational value of this module lies in cultivating students' life cycle assessment thinking and sustainable development perspective. In the teaching process, AI-driven life cycle assessment tools can be introduced, allowing students to visually compare the carbon emissions, energy consumption, and economics of different hydrogen production pathways, thereby deepening their understanding of sustainable development concepts;

(ii) Hydrogen storage technology module: the educational value of this module lies in cultivating students' engineering trade-off thinking and safety awareness. Through AI-constructed knowledge graphs for hydrogen storage safety, students can systematically understand the safety boundaries and accident cases of various hydrogen storage technologies, and conduct hidden hazard identification training in virtual environments, thereby establishing a solid safety awareness;

(iii) Hydrogen utilization technology module: the educational value of this module lies in cultivating students' system integration capabilities and innovative application thinking. Using AI-assisted design tools, students can independently design fuel cell systems and validate their performance through digital twin technology, fostering the ability to solve complex engineering problems in this process;

(2) Multi-subject participation mechanism: Organize professional teachers, educational technology experts, hydrogen energy enterprise engineers and senior students to conduct discussions around the teaching of the above technical points. The discussion process is divided into three stages, as shown in **Figure 2**. This mechanism ensures that the teaching reform aligns with technological development trends while also meeting the fundamental requirements of talent cultivation;

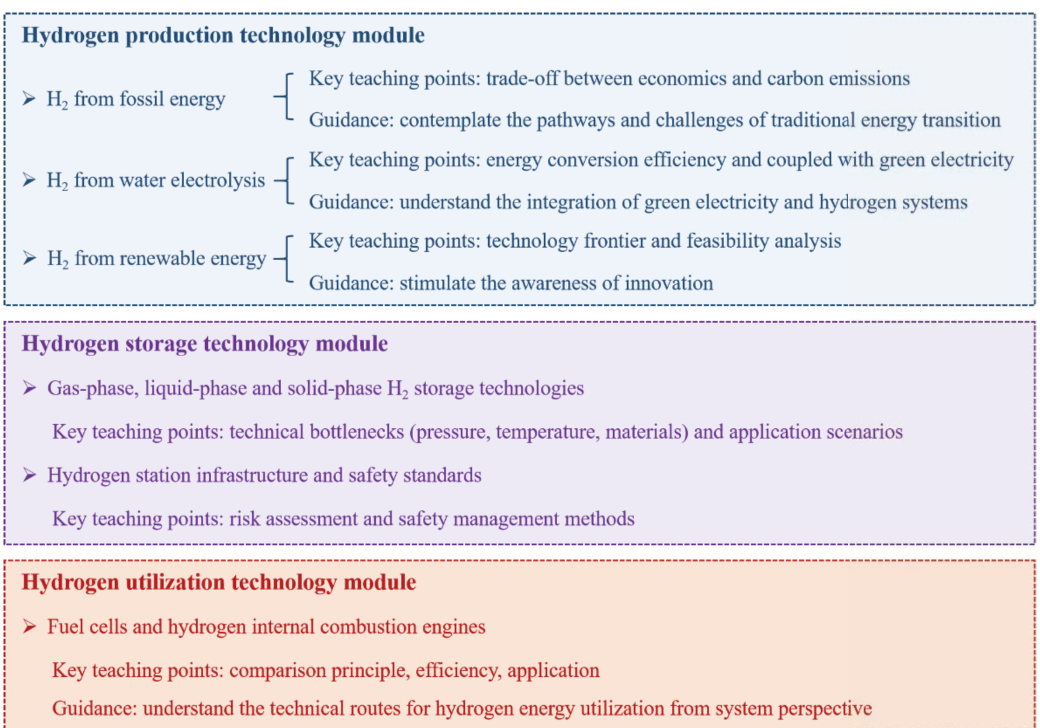

Figure 1. Deconstruction of course objectives and content.

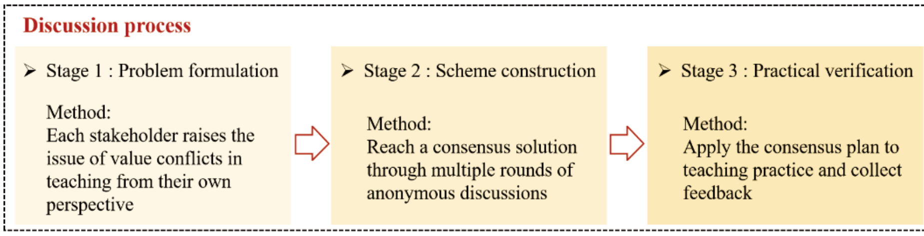

Figure 2. Multi-subject participation mechanism.

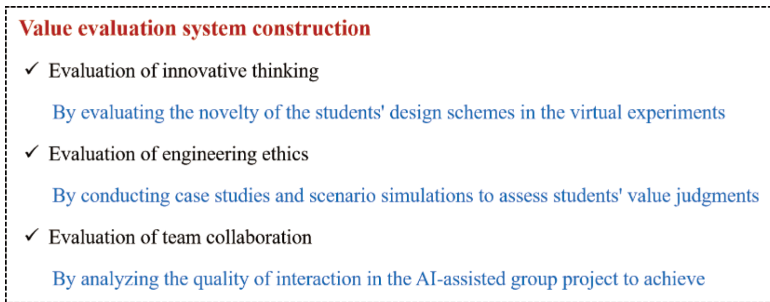

Figure 3. Value evaluation system construction.

For example, when teaching "fuel cells," AI can quickly simulate and demonstrate the performance curves of the fuel cell stack under different operating parameters. However, the core of teaching must guide students to understand the underlying principles such as its electrochemical reaction mechanism and membrane electrode degradation mechanisms, and to discuss practical challenges like cost and durability, thereby cultivating students' critical thinking and ability to solve complex engineering problems, and avoiding them becoming mere "black box" operators. To this end, a tripartite teaching segment of "principle-simulation-analysis" can be designed by explaining the basic principles through traditional teaching; then, use AI simulation to demonstrate performance variations; finally, guide students to analyze the scientific questions behind the simulation results, ensuring that technological tools serve deep learning;

(3) Value evaluation system construction: establish a diversified evaluation system that integrates technical capability and humanistic literacy. In addition to assessing the degree of knowledge acquisition through traditional means, incorporate AI-assisted formative evaluation, as shown in **Figure 3**. This evaluation system guides students to value both technical improvement and literacy development, achieving an organic unity of instrumental rationality and value rationality.

3.2.2. Developing digital teaching resources to create an AI-empowered teaching environment

To construct immersive and interactive virtual simulation teaching scenarios for course content that involves high cost, high risk, or high complexity, thereby achieving embodied cognition. By creating learning situations close to real engineering environments, students can construct knowledge and develop abilities through practice. The specific pathways and methods are as follows:

(1) Pain point identification and scenario design: Precisely identify teaching difficulties within the course that are suitable for intervention using AI and Virtual Simulation (VR/AR), as shown in **Figure 4**;

(i) For high-risk operations, simulation systems should be developed. These simulation systems should include complete job process training, handling of abnormal situations, and emergency accident response modules. Through multisensory feedback, it enhances the sense of immersion, enabling students to form a profound sense of safety in "actual experience";

(ii) For the abstract microscopic principles, visualization models should be developed. These models should support multi-scale presentation (from macroscopic devices to molecular and atomic levels), dynamic process simulation (such as proton transport pathways), and real-time parameter adjustment (such as the influence of temperature and humidity on the conduction rate), helping students build intuitive physical images;

(iii) For the integration and optimization of complex systems, a "digital twin" simulation platform should be constructed. This platform should integrate physical models, data-driven models and optimization algorithms, and support the entire process of system design, operation simulation and performance evaluation, allowing students to experience a complete engineering practice;

(2) Resource development and technology integration: Establish a five-step development process: "demand analysis-prototype development-expert review-pilot application-iterative optimization" to ensure the quality and applicability of digital resources. Technically, utilize AI to enable intelligent tutoring and personalized content recommendation. Simultaneously, focus on the organic integration with traditional teaching resources, forming a closed-loop learning environment of "offline theoretical instruction-online preview/review-virtual practical training;"

(3) Implementation and evaluation: Adopt a design-based research approach to iteratively develop and refine the virtual scenarios through teaching practice. Each implementation cycle includes a preparation phase (analysis of teaching objectives, technical solution design), an implementation phase (organization of teaching activities, data collection), an analysis phase (effect evaluation, problem identification), and an optimization phase (solution revision, resource updating). Evaluate the effectiveness in enhancing students' depth of understanding, memory retention, and practical ability through pre- and post-questionnaires, interviews, and analysis of operational data. Evaluation dimensions include: degree of knowledge mastery (via standardized tests), level of skill improvement (via practical assessments), changes in learning motivation (via scales), and development of thinking patterns (via interview analysis).

3.2.3. Fully leveraging human-machine synergy: Shaping AI-empowered teacher role

To leverage AI-driven data for decision-making, enabling dynamic adjustment of teacher roles and precise refinement of teaching strategies. Establish a collaborative division of labor characterized by "AI handles routine tasks-teachers focus on innovation," fully leveraging their respective strengths to enhance teaching effectiveness. The specific pathways and methods are as follows:

(1) Diversified teaching and data collection: Employ a mix of teaching models throughout the instructional process, such as the flipped classroom (for foundational knowledge transmission), project-based learning, and virtual

- **High-risk operation**

  Knowledge point: stress analysis of high-pressure gaseous hydrogen storage tanks

  Method: develop VR simulation for security training

- **Microscopic principles**

  Knowledge point: proton conduction mechanism in proton exchange membrane

  Method: develop an AR visualization model for the microscopic world

- **Complex system**

  Knowledge point: dynamic matching and energy efficiency optimization of wind-hydro hybrid system

  Method: build a "digital twin" simulation platform

Figure 4. Pain point identification and scenario design.

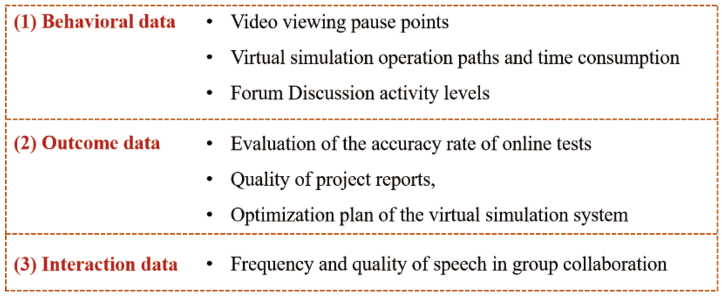

Figure 5. Diversified teaching and data collection.

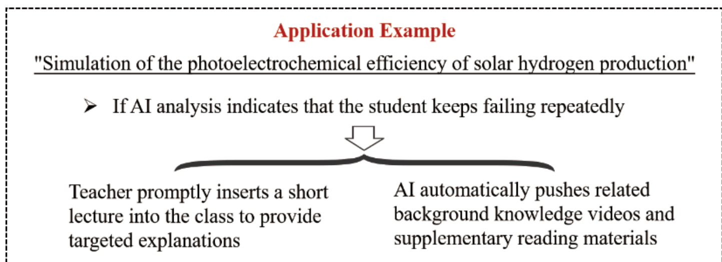

Figure 6. Feature analysis and teaching decision-making case.

simulation experiments. During these activities, multi-dimensional data is collected unobtrusively and throughout the process, as shown in **Figure 5**; Data collection should adhere to the principles of "minimally necessary" and "informed consent," ensuring adequate protection of student privacy. Concurrently, establish a data quality management mechanism, including data cleaning, outlier handling, and missing value imputation, to ensure the reliability of data analysis.

(2) Feature analysis and teaching decision-making: Employ data mining techniques to perform feature analysis on the aforementioned datasets. Use cluster analysis to identify different types of learners (e.g., surface learners, deep learners, practice-oriented learners, etc.). Use association rule mining to discover intrinsic links between learning behaviors and outcomes. Use sequence analysis to reveal student learning path preferences. One application example as shown in **Figure 6**;

(3) Teacher professional development support: Establish an "AI literacy enhancement program" to help teachers adapt to their new roles. The program should include: technical training (use of AI tools, basics of data analysis), pedagogical updates (design of blended learning, organization of project-based learning), and collaboration skills development (human-machine collaboration, team teaching). Support teacher professional growth through various formats like workshops, teaching research communities, and instructional consulting;

(4) Continuous improvement loop: Based on the analysis reports provided by the AI, teachers summarize the effectiveness of different teaching models (e.g., pure theoretical lecture, pure virtual simulation, project-based learning) on student mastery of different knowledge types (e.g., conceptual knowledge, procedural knowledge, system design knowledge). This provides a scientific basis for the continuous improvement of the next course iteration. Furthermore, establish a teacher-AI collaborative teaching research mechanism where teachers translate teaching experience into optimization suggestions for AI algorithms, and the AI translates data analysis into supporting information for teaching decisions, achieving genuine "teaching determined by learning" and "human-machine collaborative teaching research."

3.2.4. Building multi-dimensional assessment system to ensure quality of AI-empowered teaching

To establish a multi-dimensional assessment system that integrates formative and summative assessment, supplements quantitative with qualitative methods, and coordinates machine evaluation with teacher evaluation, thereby comprehensively reflecting the development of students' knowledge, abilities, and literacy. The specific pathways and methods are as outlined:

(1) Utilize AI technology to enable continuous tracking and dynamic evaluation of the learning process. This includes knowledge mastery evaluation, conducted through online quizzes and assignment analysis; ability development evaluation, conducted through the analysis of virtual experiment operations and project process records; literacy cultivation evaluation, conducted through the analysis of learning behavior data and mining of interaction content. AI can automatically generate learning profiles, providing a visual representation of students' strengths and weaknesses;

(2) For project-based learning outcomes, implement a dual evaluation mechanism involving AI initial review and teacher re-evaluation. AI is responsible for evaluating the completeness, standardization, and basic metrics of the outcomes. The teacher focuses on evaluating the innovation, practicality, and depth of thinking demonstrated in the outcomes. Simultaneously, introduce peer assessment and self-assessment mechanisms to cultivate students' metacognitive abilities and critical thinking;

(3) Evaluate students' awareness of engineering ethics and social responsibility through methods such as scenario-based judgment questions, case analysis tasks, and ethical discussions. AI can provide a rich repository of assessment scenarios and cases, and automatically analyze students' value orientations. The teacher, through in-depth interviews and observations, evaluates the maturity of students' value judgments;

(4) Establish a closed-loop mechanism of "assessment-feedback-improvement". AI automatically generates personalized learning reports, providing students with improvement suggestions. Teachers adjust teaching strategies based on the overall class assessment results. Educational administrators optimize curriculum design and resource allocation using macro-level assessment data.

4. Conclusion

The empowerment of higher education by artificial intelligence is far from a mere technological add-on; it represents a profound transformation touching the very core of education. For cutting-edge interdisciplinary fields such as New Energy Science and Engineering, this transformation presents both a challenge and a significant opportunity. The systemic reform framework proposed in this paper, anchored in "value integration as the soul, environment reconfiguration as the foundation, and role transformation as the essence", aims to return to the fundamental mission of fostering virtue and cultivating talents in education. It seeks to fully leverage the efficacy of AI technology while steadfastly upholding the humanistic warmth and value guidance inherent in education. Through the pioneering pilot implementation in the "Hydrogen Energy and Fuel Cell Technology" course, we aspire to explore a scalable and transferable pathway for intelligent talent cultivation, thereby contributing to the high-quality development of higher education.

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Development Ideas for Environmental Majors under the Background of Ecological Civilization Construction in the New Era

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Abstract

Ecological civilization construction and environmental science and engineering disciplines are all committed to achieving coordinated economic, social, and environmental development. To integrate the concept of ecological civilization construction into environmental science and engineering disciplines, it is necessary to carry out profound reform in many aspects, such as education philosophy, curriculum construction, etc. The task is extremely arduous. Therefore, this paper discusses the development strategy of the environmental discipline at Qilu University of Technology from the perspectives of strengthening the concept of ecological civilization, curriculum system structure, internships and practical training, and integration of production, learning, and research. It provides experience for the development of other environmental disciplines.

Keywords

Curriculum setting; Ecological civilization construction; Environmental discipline

Online publication: August 26, 2025

1. Introduction

The report of the 19th CPC National Congress pointed out: "Building ecological civilization is a millennial plan for the sustainable development of the Chinese nation." In the process of building a beautiful China, whether it is the establishment of ecological civilization concept, economic structural adjustment, lifestyle transformation, or institutional construction of ecological civilization, all of them cannot be separated from the participation and contribution of education.

Environmental science and engineering is a broad academic field that studies the interactive relationship between human social development activities and the evolution laws of the environment, and seeks ways and methods for the coordinated evolution and sustainable development of human society and the environment. In the future development, environmental science and engineering will provide scientific basis and technical support through ecological evaluation, environmental monitoring, and ecological restoration, thus the undergraduate environmental science and engineering majors in universities bear a sacred mission of cultivating professional and technical knowledge and skills, as well as innovative talents with high quality for ecological civilization construction [1].

This paper takes the Environmental Science and Engineering Department of Qilu University of Technology and Engineering as an example to simply discuss the development ideas of environmental science and engineering majors in the new era of ecological civilization construction.

2. Strengthen the concept of ecological civilization education

At present, China is vigorously promoting the construction of the "five-in-one" system, and the construction of a resource-saving and environmentally-friendly society is not only the target orientation of economic development mode in the present and the future, but also the value orientation of environmental-related professional courses in the reform of ideological and political education [2,3].

One way is to guide students to deeply understand and recognize the great significance of ecological civilization construction through relevant courses on the theoretical basis, policies and regulations, and practical cases of ecological civilization construction, such as courses on environmental economics and policies, environmental law, and restoration ecology.

We offer a series of comprehensive elective courses on ecological civilization to the entire student body, such as "Environmental Protection and Sustainable Development," "Ecological Security and National Security Strategy," and "Decoding Green and Low-carbon Development to Build a Beautiful China." These courses aim to guide students to learn, reflect, and practice the ecological civilization thought, and work together to safeguard the national ecological security. Additionally, we have launched a series of lectures on the ecological safety and national security strategy of the Yellow River, which have been presented to the entire student body. The themed lectures include "Ecological Safety and National Security Strategy of the Yellow River," "The Source of Life-Our Water," and "The Impact of Agricultural Non-point Source Pollution on the Environment." These lectures aim to guide teachers and students to uphold the spirit of the Yellow River culture and establish a correct ecological security concept, thus shouldering the responsibility of safeguarding national security [4].

3. Strengthen the practical teaching process

Environmental science and engineering is a practical science and technology major, requiring students to have strong practical skills, so the Environmental Studies Department has always attached great importance to practical teaching and has taken various measures to improve students' practical ability [5,6].

By forming a team of college student volunteers, the department has taught community residents and students of all ages about environmental knowledge and promoted green and low-carbon lifestyle concepts, mobilizing them to carry out environmental cleanup activities with practical actions, thus practicing ecological civilization ideology and green development view. Environmental Science and Engineering Department has held a series of special lectures and outdoor science popularization exhibitions on major commemorative days, advocating that teachers and students work together to build a harmonious relationship between man and nature in a modernized society. It has established social practice teams and sent them to the Huanghe Culture Museum in Dongying and the ecological protection area at the mouth of the Huanghe River to carry out learning and practice activities.

Environmental Science and Engineering Department has encouraged students to join research teams and organized them to participate in environmental protection projects, environmental monitoring, and ecological restoration practical activities. In 2024 alone, the department's students won more than 30 awards in various academic competitions, enhancing their practical ability and innovative thinking. Furthermore, the Environmental Science and Engineering Department has conducted offline internship and practice activities, taking students to factories for visits and encouraging them to go to enterprises for fixed-position internships, helping them apply the knowledge they have learned in class to actual work.

4. Optimize course setting and content

The new era's high-quality development has put new demands on the industry, and the breadth of knowledge needs to be expanded; the full industrial chain upgrade has put new demands on environmental protection personnel [7,8]. In order to better adapt to social development needs and keep pace with the era of carbon neutrality and carbon peak, the Environmental Science and Engineering Department has constantly updated its teaching content, incorporating the latest environmental protection technologies, policies, and concepts into its teaching system to ensure that students have the most up-to-date knowledge and skills. The department has also optimized its curriculum structure and enhanced practical teaching, aiming to cultivate high-quality environmental professionals capable of addressing complex challenges and driving green innovation.

5. Strengthen the construction of the faculty team

The responsibility of ecological environmental protection is significant, and it is urgent and necessary to establish a professional, standardized and normative talent team in the field of environmental protection. The faculty regularly organizes teacher training activities, which can not only improve teachers' professional competence and teaching ability, but also enhance their knowledge and skills in ecological civilization construction. At the same time, the faculty actively introduces outstanding talents in environmental science and engineering from both at home and abroad to strengthen the faculty team and improve the overall teaching level.

6. Promote scientific research and cooperation between industry, academia and research

The Environmental Science and Engineering Department is a unit integrating education, science and technology, and industry. The faculty actively cooperates with enterprises to do the following:

(1) Establish internship and practice training bases outside the school to provide students with more internship opportunities, enabling them to practice operations and implement projects in real scenarios, thereby improving their ability to solve practical problems;

(2) By cooperating with enterprises to carry out practical projects, students can exercise their practical operation ability, teamwork ability and problem-solving ability in the projects;

(3) Invite professional personnel from the business sector to serve as student mentors, regularly exchange with them, and provide students with industry experience and career development advice.

7. Take a diversified teaching approach and improve the evaluation system

Innovating teaching methods and means is one of the important ways to ensure that classroom teaching is centered on students [9]. Using virtual simulation technology to simulate real work environments allows students to feel as if they are there in person, thereby enhancing their sense of exploration. Using various media resources such as animations, audio and videos makes students more intuitively aware of the content of knowledge, thereby stimulating their learning interest. Organizing students to engage in group activities allows them to learn knowledge and solve problems through cooperation.

In the evaluation system for courses, increase the proportion of the score for regular performance, add points for elements such as political literacy, practical operation, case discussion, etc., to promote students' reflection and exploration of environmental concepts and ecological civilization issues from multiple perspectives, thereby strengthening students' education in ecological

8. Conclusion

Through continuous reform and innovation, the professional construction and academic development of the Environmental Science and Engineering Department have achieved some achievements, but there are still some challenges in promoting ecological civilization education, mainly manifested in the need to deeply integrate talent chains and innovation chains, industrial chains with professional practice teaching, and the task of integrating professional practice teaching is arduous. Looking to the future, the Environmental Science and Engineering Department of Qilu University of Technology will continue to adhere to the development philosophy of "integrating environmental education to cultivate moral character", actively participate in environmental education, and continuously supply talents for the construction of ecological civilization of our country.

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A Study on English Translation of Chinese Classics in Higher Education

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Abstract

Against the backdrop of profound changes in the global cultural landscape, promoting outstanding Chinese traditional culture internationally is a core strategy for enhancing the country's cultural soft power. Translating classical literature into English serves as an important means of conveying the spiritual essence and wisdom of Chinese civilization. This not only holds cultural value but also carries far-reaching strategic significance, making it a focal point of interdisciplinary research. This paper highlights potential tensions in the development of this field: despite benefiting from strategic guidance at the highest level, there remain limitations in foundational capacity-building. Even with political support, the project faces numerous challenges, including the 'cultural deficit' in translated works, a lack of talent able to navigate multicultural contexts, and a mismatch between university translation teaching methods and societal needs. Through a systematic review of local and international research pathways, methodological developments, and the field's consensus, this study identifies persistent gaps and proposes strategic directions for the future. These directions include establishing a solid framework of translation ethics, enhancing audience-based experimental research methods, utilizing digital technologies, and expanding the vocabulary of translated texts. The ultimate success of the field lies in a strategic shift from a product-centered to an audience-centered model of cultural exchange, enabling Chinese culture to evolve from merely 'going global' to achieving 'effective integration' in global cultural discourse.

Keywords

Chinese classics; Cross-cultural communication; Cultural transmission; Ideological and political education; Translation pedagogy

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1. Introduction

Amid the significant transformation of the global cultural landscape, effective international communication of China's traditional culture has emerged as a central strategy for enhancing the country's national cultural soft power. English translations of Chinese classical texts serve as vital conduits for transmitting the core values and intellectual heritage of Chinese civilization, thereby holding considerable strategic importance in cultural diplomacy. This essay contends that the translation and global promotion of Chinese classical texts not only serve as key instruments of cultural dissemination but also constitute a pivotal area for advancing China's international influence. Furthermore, this topic has evolved into a dynamic interdisciplinary field of research, integrating perspectives from translation studies, cross-cultural communication, and cultural policy, thus underscoring the complexity and significance of this endeavor [1].

Notably, the development of this field exhibits an important dual characteristic. One one hand, it benefits from strategic guidance and political support at the national level; on the other hand, it remains constrained by basic research and has relatively weak capacity for talent cultivation. These contradictions together shape its current development model. Despite continued policy support and related resource investment, translating classical literature still faces many challenges in educational practice. From a practical perspective, both in quantity and quality, current English translations are difficult to convey the richness of ancient Chinese culture, resulting in a significant cultural gap. At the same time, translations that enter international channels still have considerable room for improvement in terms of international recognition, acceptance, and practical impact [2].

In addition, in the field of translation talent cultivation, the issue of insufficient professional personnel reserves has become increasingly prominent and is a major factor restricting its development. We must recognize that translating classical literature into English, as a complex intercultural practice, imposes high demands on practitioners. They must not only possess excellent translation skills but also have a deep understanding of traditional Chinese culture and outstanding intercultural communication abilities. However, the current education system aimed at cultivating such multifaceted talents remains imperfect, and the development of corresponding mechanisms is still in its exploratory stage.

Within the current context of college public English instruction, the integration of classical text translation remains minimal in most university foreign language curricula. This disparity reflects a significant misalignment between existing curricular frameworks and the evolving demands of industry and broader societal practice, thereby constraining the effectiveness of talent development in this field. In response, this essay systematically examines both macro-level contextual factors and micro-level practical challenges encountered in the translation of Chinese classical texts in higher education settings. Specifically, the analysis will first outline the gap between current curricular offerings and professional requirements, then assess the broader socio-cultural and institutional influences shaping translation practices, and finally propose targeted strategies to address these issues. By providing this structural roadmap, the essay aims to establish a foundational understanding of current challenges while elucidating pathways to advance the field and foster its sustainable development [3].

2. Literature review

2.1. Domestic research evolution

Local studies on translating Chinese classical books into English show distinct stage-based development characteristics and can be divided into three main periods [4]. In the first period (the 1980s and 1990s), academic research mainly focused on systematically summarizing translation techniques, emphasizing the handling of culturally specific vocabulary and the unique grammatical structures found in poetry and classical texts. The research outcomes of this period primarily focused on comparative analyses of translations of major classical works, such as the Analects and the Daodejing, employing empirical inference and case study methods.

With the arrival of the new millennium, the 'cultural turn' in translation studies has prompted local researchers to go beyond the traditional boundaries of research focused solely on language transfer, expanding their academic horizons to encompass broader cultural transmission [5]. Academic research in this stage has two notable characteristics:

(1) The critical adoption of Western translation theories (such as 'deep translation' and the 'foreignization/domestication' strategies), adjusted to fit the local context;

(2) An expansion of research topics, gradually shifting from early philosophical classics to poetry, drama, novels, as well as scientific and medical texts.

Researchers began to focus on deeper themes such as translator competence, the construction of cultural identity, and the relationship between translation and ideology. Research methods also evolved from simple text comparisons to comprehensive approaches that combine the analysis of translations from different periods with studies of socio-cultural contexts. At the theoretical level, researchers have systematically re-examined the once highly esteemed theory of 'deep translation.' This theoretical reflection extends beyond translation strategies to explore its philosophical foundations and the limits of its application. Relevant studies indicate that overreliance on minor components of the text may weaken the translation's core, while excessive interpretative authority on the part of the translator may lead to the formation of a monopolistic cultural discourse [6]. For example, through detailed analysis of classical translations such as "The Warm Whip Dragon," although footnotes, prefaces, and other supplementary appendices aid in cultural understanding, they may also become means for translators to insert personal academic views or specific value-laden stances.

Early studies were usually composed of sharing individual educational experiences. In recent years, however, a theoretically oriented educational system with professional characteristics has gradually emerged. This system focuses on the concept of "three-dimensional integration" in education. At the level of knowledge construction, it emphasizes the simultaneous development of language skills and humanistic culture; at the methodological level, it stresses the organic combination of theoretical teaching and practical training. At the level of educational objectives, it is committed to the joint improvement of academic literacy and communication abilities. Many universities adopt a progressive teaching model, including "intensive reading of classical texts, translation workshops, and simulations of multicultural exchange scenarios," and, through real translation projects, effectively enhance students' practical application skills.

Research on the English translation of classical Chinese texts demonstrates different developmental paths in international sinology. Early Western studies from the 19th century to the mid-20th century were characterized by features typical of the colonial era. During this period, most missionaries and sinologists took a Eurocentric stance in their academic research and tended to employ deep domestication strategies in translation to meet the aesthetic and intellectual expectations of target-language readers. Although this translation practice helped introduce Chinese classical texts to the West in its early stages, it also, to some extent, reinforced Western stereotypes of Chinese culture.

2.2. International research trajectories

Since the end of the 20^{th} century, with the rise of postcolonial theory and cultural studies, the concept of translation in Western Sinology has undergone significant changes. The new generation of Chinese scholars place greater emphasis on preserving the cultural characteristics of the source text in translation, often employing in-text annotations and cultural footnotes to balance translation readability with cultural preservation. It is particularly noteworthy that Western scholars were among the first to apply reception theory in this field, focusing on the impact of translation and its reception within the target cultural context. This reader-oriented research perspective provides important methodological references for translation practice, including the translation of classical studies into English. In research, a comparative cultural perspective has become a prominent feature of Western studies. Researchers typically analyze Chinese classical texts within the broader framework of world literature and, by comparing them with other civilizations (such as the Chinese and Indian classical civilizations), reveal the unique value of Chinese culture and its global significance. This cross-civilizational research approach not only broadens the scholarly perspective for translating classical texts into English but also creates new theoretical space for China's participation in global dialogue.

2.3. Convergence and innovation in research paradigms

In recent years, local and international academic traditions have shown significant convergence in the translation of classical literature into English. Methodologically, this integration is reflected in Chinese scholars' efforts to maintain the advantages of traditional linguistic analysis while actively adopting the multidisciplinary approaches prevalent in Western research. At the same time, Chinese scholars educated in the West are more actively engaged in local academic dialogues and prioritize accurately conveying the original cultural meanings in their translation practices. The collaborative focus of scholars from different backgrounds has facilitated the emergence of multidisciplinary research, and the methods employed in digital humanities exemplify this harmony. Researchers now widely use natural language processing technology and big data analysis to conduct quantitative and historical investigations of translation practices, thereby revealing the development of translation traditions and providing empirical evidence for current methods [7].

In addition, academic attention to translation ethics has been increasing, and Chinese research on the scope of translator effectiveness resonates with international discussions on the political influence of cultural representation. Overall, these developments reflect the deep methodological complexity and the growing ethical awareness in the field. In summary, the ongoing systematic exchange, the application of digital tools, and the shared commitment to ethical reflection all indicate that research on the English translation of classical literature is progressing toward greater theoretical maturity and interdisciplinary integration, laying a foundation for more precise and efficient future studies.

3. Research methods and consensus

3.1. A pluralistic methodological system

In long-term research practice, the field of translating classical English texts gradually took shape, forming a comprehensive, systematic framework for research methods. This system is grounded in qualitative research and integrates multiple research methods to support the in-depth development of the discipline. Textual criticism and comparative analysis are two fundamental research approaches in which the researcher must study the original text and its translation, word by word, with particular attention to key cultural concepts, distinctive rhetorical devices, and the translation's structural characteristics [8]. Through meticulous textual analysis, the researcher can understand the translation strategies employed by translators and the underlying cultural stances they reflect. In recent years, this approach has evolved from merely comparing translations to a three-dimensional analytical model that includes 'the original text-the translated text-the supplementary text,' and the scope of research has expanded to include supplementary textual materials such as prefaces, footnotes, and commentary.

Longitudinal studies offer an important historical perspective to the academic field. By examining different translations of the same text over different time periods, researchers can trace the evolution of translation standards, cultural attitudes, and academic trends. For example, the ten key translations of the book "Daodejing" over more than a hundred years in the West clearly demonstrate the trajectory of changes in the Western understanding of Chinese culture. This longitudinal research method helps recognize the dynamic characteristics of translation activity and avoid simplistic judgments of translation phenomena. Case studies are considered an effective means to deepen theoretical understanding. Researchers typically select translations or translation phenomena with representative characteristics for in-depth analysis, such as studying classical Confucian translations by Rijak, or translations and research in Chinese literary criticism by Liuben Swan, among others. These case studies enhance understanding of specific translation practices and provide rich empirical material for theoretical reflection.

The applications of interdisciplinary research methodologies are becoming increasingly widespread. Scholars draw theoretical resources from fields such as hermeneutics, reception theory, discourse analysis, and cultural studies, continuously enriching the tools for analyzing the understanding of translation phenomena. In particular, with the development of digital humanities techniques, corpus-based methodologies have been introduced into research on translating classics into English, through big data analysis to uncover the underlying patterns of translation practices. After extensive scientific research, several important consensus points have emerged in the field of translating classics into English. Understanding of the nature of translation has become largely unified, with academics generally believing that translating classics into English is not merely a simple linguistic transfer, but a complex cultural practice and a discourse-constructing process. This understanding broadens the research perspective from the technical level of "how to translate" to the cultural level of the motivations behind "why it is translated in this way".

3.2. Established consensus within the field

Regarding translation standards, the academic community has reached a more comprehensive understanding. Researchers generally believe that translating excellent classical texts requires a balance between cultural accuracy, reader acceptability, and aesthetic value. This balance should be based on a profound understanding of the translation's objectives and an accurate grasp of the readers' needs. There is also a clear consensus regarding the skills required of translators. Qualified translators of classical texts need to possess three abilities: proficiency in both languages, deep cultural knowledge, and a thorough awareness of cultural communication. Cultural knowledge includes not only an in-depth understanding of the source language's culture but also familiarity with the target language's cultural background. Comprehensive ability is regarded as a significant advantage in cultivating translators of classical texts. As for teaching and research, the principle of combining theory with practice has been widely accepted. Researchers emphasize that teaching translation of classical texts should go beyond traditional lecture methods by creating authentic or simulated translation scenarios that allow students to deepen their theoretical understanding through practice. New teaching methods, such as project-based learning and workshops, have gained wide recognition and are increasingly being applied.

In terms of publishing strategy, the academic community emphasizes the principle of precise publishing based on target levels and categories. Researchers may recognize that different reader groups have diverse needs when translating classical literature; therefore, translation strategies and publishing methods suitable for both professional researchers and general readers should be employed. This awareness of the audience indicates that research on translating classical literature into English has entered a mature and developmental stage. The emergence of these concepts not only reflects the theoretical achievements of research on translating classical literature into English but also highlights future trends. As research deepens, this methodological framework will continue to be refined, thereby promoting the development of the field of classical literature translation.

4. Discussion

Based on a preliminary analysis of current trends and methodological developments, it is necessary to highlight the main limitations in this field and identify potential avenues for future research. Although significant progress has been made in translating Chinese classical texts into English, persistent structural and conceptual gaps still require systematic attention. In this section, the focus will explicitly shift to discussing these research gaps by evaluating unresolved theoretical, methodological, and practical challenges. In this way, strategic directions are proposed to improve existing models, thereby fostering an academic environment that encourages deeper, more comprehensive studies of the translation of Chinese classical texts [9].

Although significant progress has been made in the study of translating Chinese classical texts into English, this research model urgently requires a structural transformation. Currently, academic perspectives and research methods largely follow traditional paths, focusing on the 'translator' and paying excessive attention to source-text analysis and the exploration of translation strategies. To advance this field from mere linguistic conversion to deep cultural transmission, it is imperative to expand the scope of research to cover the entire publishing process and to focus on four main strategic directions:

(1) On the level of translation ethics and methodology, current studies still need to deepen the discussion on the subjectivity of the translator, especially the need to find ways to stimulate the translator's creativity while establishing effective control mechanisms. The future should focus on developing a methodological framework for translation

ethics, establishing applicable standards, and determining the translator's balance point between cultural fidelity, academic standards, and artistic creativity. By developing specialized databases, terminological guides, and other tools, a reference can be provided for conveying cultural concepts, allowing the translator's subjectivity to play a constructive role within a framework of controls;

(2) Considering the current weak assessment of publication impact, there is a need to drive the shift of research patterns towards an experimental approach, actively incorporating research methods from media and sociology. Through audience surveys, in-depth interviews, and group data analysis, the dissemination paths of translated works and their impact on the target cultural environment are systematically studied, aiming to establish a data-driven evaluation system that provides a scientific reference for translation practice;

(3) In the face of transformations in the digital age, the use of modern technology should be promoted in all stages of translating classical books. It is possible to explore the benefits of translation rules revealed by big data analyses, develop interactive human-machine translation models, and utilize virtual and augmented reality technologies to create new ways to present classical books. At the same time, the potential of social media platforms to enhance bilateral interaction and build deeper reading communities abroad should be studied;

(4) In terms of research areas, it is essential to address the current limitations that predominantly emphasize Confucian and Daoist classics by systematically expanding the scholarly scope to encompass a broader corpus. This expansion should include rationalist philosophical works from the Song and Ming dynasties, ancient scientific and technological treatises, cultural texts produced by ethnic minority groups, and other diverse genres. Such inclusivity is necessary to represent the multifaceted nature and cultural complexity of Chinese civilization.

5. Conclusion

In conclusion, the advancement of English translation studies of Chinese classics depends on transitioning from a translation-centered approach to one centered on audience reception and engagement. By refining theoretical frameworks, advancing research methodologies, and broadening the corpus of texts under consideration, the field can develop a more robust and integrative academic paradigm. In summary, these efforts are crucial for fostering a richer international understanding of Chinese culture and facilitating its broader acceptance within the global cultural discourse.

Disclosure statement

The author declares no conflict of interest.

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Innovative Design of a Dual-Qualified, Dual-Skilled, and Dual-Capable Training System for Vocational College Teachers in an Enterprise HR Student-Oriented Evaluation Framework

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Abstract

The core mission of vocational education is to cultivate high-quality technical and skilled talents that meet industry demands. The "Dual Qualifications, Dual Excellence, Dual Competencies" framework for teachers (i.e., "Dual Qualifications": Dual qualifications as both educators and technicians; "Dual Excellence": High teaching standards and strong practical skills; "Dual Competencies": Curriculum development and workplace guidance capabilities) serves as the key pillar for achieving this mission. Centered on corporate HR student evaluations, this study analyzes the disconnect between current vocational university teacher training systems and enterprise talent demands. By integrating HR assessment data on graduates' job adaptability, professional competence, and practical skills, it establishes a closed-loop training system encompassing "demand diagnosis, content restructuring, model innovation, implementation assurance". Through literature analysis, corporate surveys, and case studies, the research clarifies the mapping relationship between HR evaluation metrics and teacher competencies. Ultimately, it proposes innovative solutions including modular curriculum systems, industry-academia collaborative training, and dynamic evaluation feedback mechanisms, providing practical pathways for vocational universities to enhance faculty development quality and improve alignment between talent cultivation and industrial needs.

Keywords

Dual-qualified dual-skilled dual capability; Enterprise HR evaluation; Innovative design; Teacher training system; Vocational college

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1. Introduction

1.1. Research background

The National Vocational Education Reform Implementation Plan explicitly proposes to "build a high-level dual-qualified faculty team," requiring vocational college teachers to possess both solid teaching expertise and robust industry practice capabilities. However, most vocational university teacher training systems still focus primarily on "improving in-house teaching skills," neglecting enterprises actual talent demands. As direct participants in graduate recruitment and position evaluation, corporate HR professional assessments of students professional competence, practical skills, and job fit serve as crucial benchmarks for evaluating teaching effectiveness and driving faculty development.

Research indicates that 72% of corporate HR professionals identify vocational college graduates with challenges such as "inadequate practical skills" and "weak professional awareness." The root cause of these issues lies in the lack of "dual-qualified, dual-skilled, and dual-capable" teachers. While some instructors hold dual-qualification certifications, their absence of frontline industry experience results in teaching content that fails to align with real-world job requirements. Meanwhile, teachers with strong practical skills often struggle to adapt industry technologies into curriculum materials that match students' cognitive levels. Therefore, integrating corporate HR student evaluations into teacher training systems has become the key breakthrough to address the disconnect between "teaching" and "application."

1.2. Research significance

1.2.1. Theoretical significance

This study breaks through the traditional "school-centered" single perspective in teacher training, establishing a theoretical logic chain of "enterprise HR evaluation-teacher competency enhancement-talent cultivation quality optimization". It enriches the "demand-oriented" research dimension in vocational education teacher development theory, providing new theoretical support for defining the connotation and evaluation criteria of "dual-qualified, dual-skilled, and dual-capable" teachers.

1.2.2. Practical significance

By innovatively designing teacher training systems tailored to corporate needs, we can directly enhance educators' ability to transform industrial technologies into teaching resources, thereby improving students job adaptability and career competitiveness. Simultaneously, this establishes a collaborative mechanism between vocational colleges and enterprises covering talent evaluation, teacher training, and school-enterprise cooperation, enabling vocational education to better serve regional industrial development.

1.3. Research methods and framework

1.3.1. Research technique

A systematic review was conducted of both domestic and international research related to vocational education teacher training and corporate involvement in talent evaluation. The review aimed to clarify and conceptualize the framework of "Dual Teachers, Dual High Qualifications, and Dual Competencies," identifying its theoretical foundations and practical implications. Key HR assessment indicators commonly used in enterprise talent evaluation were also analyzed to establish a basis for the empirical components of this study.

To obtain first-hand data on industry evaluation of vocational graduates, semi-structured interviews were carried out with HR departments from ten representative manufacturing and service enterprises. The survey focused on collecting quantitative and qualitative data, including graduate job skill attainment rates, professional competency scores, and overall employment performance. Statistical and correlational analyses were then applied to examine the relationships between these enterprise evaluation metrics and the teaching competencies of vocational education instructors.

A pilot implementation was conducted using the Mechatronics program at Hainan Vocational University of Science and Technology as a case study. The training system developed in this research was applied within the program to assess its practical feasibility and effectiveness. Data were gathered through classroom observation, performance assessments, and enterprise feedback on student internship performance. The outcomes were analyzed to evaluate the alignment between the proposed training framework and real-world competency development needs.

2. Definition of core concepts and literature review

2.1. Defining core concepts

Corporate HR student evaluations refer to systematic assessments conducted by corporate human resources departments during recruitment, probation periods, and position evaluations. These evaluations assess graduates job fit (alignment between professional skills and job requirements), professional qualities (responsibility, teamwork, execution capabilities), and development potential (learning capacity, innovative awareness). The evaluation results directly reflect whether students meet corporate hiring standards while indirectly indicating the alignment between faculty teaching and industry demands [1–3].

The "Dual Qualifications, Dual Excellence, Dual Competencies" framework for vocational college instructors, grounded in existing research and industry demands, is defined as follows:

(1) Dual qualifications: Possess both a university teaching qualification and an industry technician-level certification or higher, with at least one year of frontline corporate experience [4];

(2) Dual excellence: Demonstrate high pedagogical proficiency (designing student-adaptive curricula and utilizing digital teaching tools) and strong practical expertise (mastering cutting-edge industry technologies to resolve real-world technical challenges);

(3) Dual competencies: Develop curriculum design skills (translating corporate technical standards into course content) and job guidance capabilities (mentoring students in workplace practices and troubleshooting technical issues during training) [5].

2.2. Literature review

2.2.1. Status quo of domestic research

Domestic scholars research on "dual-qualified" teacher training primarily focuses on "school-enterprise cooperative training models". For instance, Wang proposed a dual-track training model combining "on-the-job enterprise practice + in-school teaching seminars", though she failed to directly link corporate HR evaluations with teacher training. Zhang highlighted the disconnect between vocational college teacher training content and industry needs, yet did not propose concrete solutions guided by HR evaluation data [6].

2.2.2. Current situation of overseas research

In Germany "dual system" vocational education, companies directly participate in teacher training and curriculum design. For instance, Siemens provides regular technical training for vocational school teachers, but this model relies heavily on corporate involvement, making it difficult to directly apply to Chinas vocational education landscape. Meanwhile, U.S. community colleges use "employer advisory boards" to gather talent demands, yet fail to establish a closed-loop mechanism integrating HR evaluations with teacher training [7].

2.2.3. Research review

Existing studies have realized that the teacher training of vocational colleges needs to meet the needs of enterprises, but there is a lack of systematic design that takes "enterprise HR student evaluation" as the core orientation, and fails to establish a direct mapping relationship between evaluation data and teacher ability improvement. This study is aimed at this gap [8].

3. Analysis of the problems in the training system of "double teachers, double high and double abilities" for teachers in vocational universities

3.1. Training needs assessment divorced from corporate HR evaluation, resulting in unclear objectives

Current vocational college teacher training needs assessments predominantly rely on "in-house self-evaluation," determining training content solely through faculty questionnaires and teaching supervision feedback, without incorporating corporate HR evaluations of graduates. For instance, in a vocational colleges 2023 teacher training plan, topics like "smart manufacturing technology updates" and "digital teaching methods" accounted for 60% of the content. However, HR surveys from enterprises revealed that graduates generally lack "equipment troubleshooting skills", a critical competency not reflected in the training requirements. This disconnect between training objectives and actual corporate needs makes it challenging to effectively enhance the "high practical skills" component of teachers "dual-high" qualifications.

3.2. The training content is overly theoretical, failing to meet the practical requirements of the "dual-qualified, dual-skilled, and dual-capable" model

The training content remains predominantly theory-based, lacking integration with frontline enterprise technologies and job scenarios. Specifically: For "dual-qualified" teacher training, the focus is mainly on "certificate preparation guidance" while neglecting the cultivation of teachers "practical enterprise experience," resulting in instructors holding certifications but lacking real-world job understanding. For "high-quality teaching" training, emphasis is placed on "innovative teaching methods" such as micro-lecture design and flipped classrooms, yet fails to address HR evaluations regarding "students operational proficiency" through specialized training on "transforming enterprise technologies into teaching materials." Regarding "dual-capability" training, there is almost no mention of "curriculum development and job guidance," making it difficult for teachers to incorporate HR-focused "job fit" considerations into their instruction [9,10].

3.3. Single training mode and lack of school-enterprise collaboration mechanism

The current training model predominantly relies on "on-campus centralized instruction," accounting for over 80% of programs. While a small number of training sessions include "corporate visits," no collaborative training mechanism between schools and enterprises has been established. This approach presents two critical issues:

(1) Instructions lack frontline industry exposure, making it difficult for them to master "cutting-edge technologies" emphasized in HR evaluations. For instance, a teacher specializing in automotive engineering only learns "traditional engine maintenance" during training, without addressing "new energy vehicle battery maintenance", a key focus for corporate HR;

(2) Enterprises are excluded from designing and implementing training programs, resulting in content that fails to align with job requirements. Consequently, HR feedback on graduates cannot be directly translated into actionable improvements for teacher training [11].

3.4. The closed loop of training evaluation is missing, and the effectiveness is difficult to be implemented

Most vocational colleges evaluate training effectiveness solely through "exams" and "questionnaires" after completion, lacking a closed-loop mechanism of "training-teaching-HR feedback". For instance, after teachers participate in "practical skills training", the school neither monitors whether they apply the training content in teaching nor collects corporate HR evaluations of students' competency improvements. This results in training effectiveness being unverifiable through students' job performance, leaving teachers "dual-qualified, dual-skilled, and dual-capable" development without a basis for continuous improvement [12].

4. Analysis of the correlation between student evaluations of enterprise HR and teachers dual-qualified, dual-skilled, and dual-capable proficiency

To build a training system oriented by enterprise HR evaluation, it is necessary to first clarify the correlation between HR evaluation indicators and teachers' abilities, and establish a mapping relationship of "evaluation indicators-teachers ability gap-training priorities", which is the core basis of training system design [13].

4.1. Extraction of HR student evaluation indicators

Through interviews and evaluation data collection from HR professionals at 10 enterprises, three core evaluation indicators were identified, as detailed in **Table 1**.

4.2. Evaluation metrics and their alignment with teachers dual-qualified, dual-skilled, and dual-capable profile

4.2.1. Job fit index: Teachers dual high qualifications and dual competencies

The low "professional skill attainment rate" reflects insufficient "practical competence" among teachers: Their

Table 1. Enterprise HR student evaluation index table

Evaluative dimension	Core metrics	Indicator description
Position fit	Professional skill attainment rate	The degree to which students professional skills match the job requirements, such as equipment operation, technical parameter debugging, etc
	Problem solving ability in position	Students ability to independently solve common problems in their positions, such as troubleshooting and process optimization
Professional quality	Responsibility and execution	The seriousness and efficiency of students in completing their work tasks, such as timely delivery and error control
	Teamwork	The ability of students to work with colleagues, such as cross-department communication and task division
Development potential	Technical learning ability	Students quickly master new industry technologies, such as new equipment operation, software application, etc
	Consciousness of innovation	Students demonstrate the ability to improve work methods, such as optimizing operational processes and reducing costs

failure to master the latest industry technical standards results in teaching content that fails to align with job skill requirements [14,15]. This also reveals a lack of "curriculum development capability," as teachers cannot effectively translate industry standards into course materials. Meanwhile, the weak "problem-solving ability for job positions" highlights deficiencies in both "practical skills" and "on-the-job guidance capabilities." Teachers lack of real-world problem-solving experience prevents them from guiding students to simulate workplace scenarios and develop problem-solving abilities during instruction [16,17].

4.2.2. Professional competence indicators: Teachers dual excellence

The lack of "responsibility and execution" reflects the absence of "professional competence integration" in teachers "high teaching proficiency." Teachers fail to incorporate corporate job standards and work discipline into their instruction, resulting in students lack of career awareness. The weak "team collaboration skills" indicate insufficient "contextual teaching ability" in teachers "high teaching proficiency." Teachers do not design collaborative teaching activities (such as project-based learning), failing to cultivate students' teamwork awareness [18].

4.2.3. Development potential indicators: Dual-qualified teachers and dual-high qualifications

The weak "technical learning capacity" reveals insufficient "practical industry experience" among dual-qualified teachers. They fail to keep up with emerging industry technologies, making it difficult to guide students in mastering cutting-edge knowledge during instruction. This also highlights the lack of "methodological guidance skills" within their "high teaching proficiency". The inadequate "innovative awareness" reflects insufficient "technological innovation capabilities" in their "strong practical skills". Teacher's absence of corporate innovation experience prevents them from stimulating students creative thinking in classroom teaching [19].

4.3. Core implications of mapping relationships for the training system

Based on the aforementioned mapping relationship, the teacher training system should focus on three core directions: For "job adaptability", strengthen training in "enterprise practice skills" and "curriculum development capabilities"; For "professional competence", supplement training in "professional competence integration into teaching" and "contextual teaching"; For "development potential", enhance training in "industry new technology tracking" and "innovative teaching".

5. Innovative design of faculty training system for enterprise HR under student evaluation orientation

Based on the mapping relationship between HR evaluation and teachers' competence, and combined with the problems of the current training system, this paper designs an innovative training system from four dimensions: "demand diagnosis, content reconstruction, model innovation, and closed-loop evaluation".

5.1. Training needs assessment: Establishing a collaborative diagnosis mechanism for "HR evaluation and teacher competency"

Breaking away from the traditional "in-house self-assessment" model, the system adopts corporate HR evaluation data as the core basis for demand diagnosis. The specific process is as follows: At the end of each semester, vocational colleges collaborate with partner enterprises to collect HR evaluations on graduates "job fit, professional competence, and development potential," forming the "Graduates Enterprise Evaluation Report." Based on the mapping relationship between "evaluation indicators and teacher competencies," educators identify weak points in the report (e.g., "low professional skill attainment rate") and analyze corresponding competency gaps (e.g., "insufficient practical skills"). By integrating teacher self-assessments and teaching supervision feedback, a comprehensive "Teacher Training Needs List" is established to ensure training content precisely aligns with corporate requirements.

5.2. Curriculum restructuring: Developing a "three-dimensional modular" course system

Guided by HR evaluation standards and the Dual Teachers, Dual High Qualifications, Dual Competencies framework, the training program has been restructured into three core modules: Enterprise Practice, Teaching Transformation, and Competency Integration. Each module features targeted sub-courses, as outlined below:

(1) Module 1: Enterprise Practice Module (focusing on dual-qualified teachers and high practical skills)

 (i) Sub-course 1 (Enterprise Internship Training): Teachers will be assigned to frontline positions (e.g., engineer assistants or technical consultants) in partner companies for at least three months, focusing on HR-relevant technical skills (e.g., new energy vehicle maintenance, industrial robot debugging) to address the issue of teachers lack of practical job knowledge;

 (ii) Sub-course 2 (Industry New Technology Training): Invite enterprise technical experts and HR to deliver special lectures on the latest industry technical standards and job demand changes (such as "Smart Manufacturing Process Update" and "Modern Service Industry Digital Transformation"), helping teachers track cutting-edge technologies;

 (iii) Sub-course 3 (Dual-qualified Practical Training): Moving beyond theory-focused exam preparation, this model combines real-world corporate projects (e.g., equipment troubleshooting) with certification. Teachers must complete actual enterprise projects before taking the qualification exam, ensuring the dual-qualified certification is directly linked to practical skills.

(2) Module 2: Teaching Transformation Module (focusing on "Dual Competencies" and "High Teaching Standards")

 (i) Sub-Course 1 (Job-Oriented Curriculum Development): Instructors will translate HR-focused job skill standards (e.g., "logistics and warehousing workflows") into course content, master the "task decomposition, instructional design, and practical training project development" methodology, and enhance their "curriculum development capabilities";

 (ii) Sub-course 2 (Innovative Practical Teaching Methods): To address the issue of weak practical skills in HR evaluations, trainers implement project-based teaching and job simulation teaching. For example, instructors are assigned to design simulated corporate order processing training projects to enhance their job guidance capabilities;

 (iii) Sub-course 3 (Application of Information Technology in Teaching): Train teachers to use VR and simulation software to recreate workplace scenarios (e.g., "virtual factory operations"), addressing the shortage of on-campus training equipment and enhancing teaching quality.

(3) Module 3: Competency Integration Module (focusing on "Advanced Teaching Standards" and Professional Competency Development)

(i) Sub-course 1 (Professional Competency Integration): Invite HR professionals to explain job-specific competencies (e.g., quality awareness in manufacturing and service industry standards for customer support), and guide instructors to incorporate these into daily teaching (e.g., by including a quality error control assessment in practical training;

(ii) Sub-course 2 (Teamwork and Innovative Teaching): Train teachers to design "team project training" (such as "group cooperation to complete product assembly"), and introduce the enterprise "innovation proposal system" to guide students to propose improvement plans, and enhance students teamwork and innovation awareness.

5.3. Training model innovation: Implementing the "school-enterprise collaboration + dual-mentorship" training model

Breaking the single model of "centralized classroom teaching", we establish a collaborative framework where enterprises lead practical training while schools guide pedagogical transformation. The dual-mentor system assigns each participating teacher an "enterprise mentor" and a "school mentor". Enterprise mentors are typically technical experts or HR professionals from partner companies, oversee teachers practical training and job-specific skill development. School mentors are usually distinguished faculty members, assist in translating corporate technologies into teaching materials.

The three-phase training program comprises three distinct stages. The first phase (1–2 months) involves corporate immersion, where instructors work alongside frontline HR professionals under corporate mentors to master job-specific technical competencies. The second phase (2 weeks) focuses on academic adaptation, during which instructors transform workplace insights into structured course materials and hands-on training modules guided by university mentors. The final phase (1 month) emphasizes classroom implementation, where instructors apply these adapted teaching methods. Corporate and university mentors jointly observe and evaluate instruction sessions, providing actionable feedback for continuous improvement.

By integrating online and offline resources, we have established a "School-Enterprise Training Cloud Platform" to upload corporate technical videos, HR evaluation cases, and other materials for teachers continuous learning. Additionally, an online discussion forum has been created where corporate mentors and school-based instructors collaborate with teachers in real-time to address challenges in both teaching and practical application.

5.4. Closed-loop training evaluation: Establishing a four-dimensional dynamic evaluation mechanism

Moving beyond the conventional evaluation upon training completion model, we have established a closed-loop evaluation system encompassing training process, teaching application, HR feedback, and continuous improvement. This framework conducts assessments through four key dimensions:

(1) Training process evaluation involves joint assessments by corporate mentors and campus instructors regarding teachers' performance during the "Corporate Practice" and "Teaching Transformation" phases, including "proficiency in job-specific technical skills" during corporate practice and "quality of practical training project design" during teaching transformation;

(2) Teaching application evaluation assesses whether instructors effectively integrate training content into instruction through classroom observations and student surveys, such as "implementation of job simulation training". This research focuses on innovative design of the "Dual-qualified, Dual-skilled, Dual-capable" training system for vocational college teachers under student-oriented evaluation by corporate HR;

(3) HR feedback evaluation collects assessments from corporate HR regarding students taught by these teachers at the end of the next semester,

comparing pre-and post-training changes in indicators like "job adaptability and professional competence" (e.g., "increase in professional skill attainment rate"). This component accounts for 40% of the evaluation weight, validating training effectiveness through corporate needs;

(4) Continuous improvement evaluation combines results from the first three dimensions to form a "Teacher Training Effectiveness Report", analyzing system shortcomings (e.g., "discrepancies between sub-course content and corporate technology") and feeding back to the needs diagnosis phase to optimize training content and models for the next cycle, creating a dynamic "evaluation-improvement-re-evaluation" loop.

6. Safeguard measures for the implementation of the training system

The innovative design of the training system needs to be supported by perfect safeguard measures, so as to break through the barriers of school-enterprise collaboration, ensure resource input and maintain the long-term operation of the system. The safeguard mechanism is constructed from the aspects of organization, resources and system.

6.1. Organizational support: Establish a "school-enterprise collaboration" training management institution

A "Joint Management Committee for Teacher Training" has been established through collaboration between vocational universities and partner enterprises, clarifying responsibilities and breaking down communication barriers. The university committee coordinates internal resources (including distinguished faculty and training facilities), organizes teacher participation in training programs, and monitors teaching application progress. The enterprise committee, involving HR and technical departments, provides practical training positions, dispatches corporate mentors, and supplies HR evaluation data and job requirement information. The committee holds quarterly meetings to review the "Training Needs List" and "Training Effectiveness Report", addressing coordination issues such as "insufficient corporate training positions" and "delayed HR evaluation data", ensuring the training system aligns with corporate needs.

6.2. Resource assurance: Establishing a collaborative school-enterprise resource support system

Resource allocation forms the foundation for implementing the training system, requiring support in three key areas: funding, faculty, and facilities. For financial support, a "school-enterprise co-financing + government subsidy" fund pool should be established. Vocational universities should allocate 20% of their education budgets for teacher training, while partner enterprises contribute annual training funds (which can be included in school-enterprise cooperation budgets). Additionally, active applications should be submitted to local governments for "Special Subsidies for Vocational Education Teacher Development" to ensure funding for enterprise internships and new technology training programs.

Regarding faculty support, a "dual-mentor database" should be created. Enterprise mentors should be selected from technical experts and HR managers of partner companies with at least 5 years of industry experience, while school-based mentors should be chosen from distinguished teaching staff and "dual-qualified" core teachers with enterprise practice experience. A mentor evaluation mechanism should be established, using "training effectiveness" and "HR feedback" as assessment criteria to ensure mentor quality.

For facility support, schools and enterprises should jointly establish "Teacher Practice Training Bases." This includes setting up "Teacher Training Workshops" within enterprises equipped with HR-focused core equipment (such as smart production lines and modern logistics warehousing systems), and creating "Teaching Transformation Studios" on campus with VR simulation devices and course development software to provide venue support for teachers to transform enterprise technologies into teaching content.

6.3. Institutional guarantee: Improve the supporting system of "incentive + restraint"

The institutional framework establishes teachers' rights and obligations in training programs, stimulating their enthusiasm while ensuring practical outcomes. The incentive mechanism incorporates teachers' participation in "enterprise on-the-job training" and "dual-mentorship programs" into bonus points for professional title evaluations and performance assessments. Teachers demonstrating "significant student competency improvements" in HR evaluations receive special rewards (such as bonuses or priority dispatch opportunities), addressing the issue of "unwillingness to participate in training".

The constraint mechanism mandates vocational college teachers to complete at least six months of enterprise practice training every three years, with delayed promotions for non-compliance. Teachers must submit "teaching transformation plans" (including practical project designs and curriculum reform proposals) after training, which must be implemented in subsequent teaching. Failure to comply requires retraining. The school-enterprise cooperation mechanism involves signing "Teacher Training Cooperation Agreements" with partner enterprises, clarifying corporate responsibilities for providing practical positions and HR evaluation data, while schools offer technical consultations and staff training services in return. This establishes a long-term "mutually beneficial" cooperation mechanism, preventing corporate "unwillingness to participate" issues.

7. Case study: Application of training system for mechatronics major in Hainan vocational university of science and technology

In order to verify the feasibility and effectiveness of the training system designed in this study, the mechatronics major of Hainan Vocational University of Science and Technology (hereinafter referred to as "the major") was selected to carry out a one-year pilot application. The specific process and results are as follows.

7.1. Background of the pilot

The 2022 corporate HR evaluation of this program revealed three major issues among graduates:

(1) Insufficient industrial robot debugging skills (professional skill compliance rate only 65%);

(2) Low efficiency in equipment troubleshooting (job problem-solving ability score 3.2/5);

(3) Weak quality awareness (professional competence score 2.9/5).

Corresponding faculty competency gaps include insufficient industrial robot practical skills, weak ability to translate troubleshooting teaching into practice, and lack of professional competence integration.

7.2. Pilot implementation process

Based on the training system designed in this study, the following implementation work is carried out in this major:

(1) Needs analysis: Collaborating with the HR departments of three partner organizations (a smart manufacturing company and an automotive parts manufacturer), we developed the "Graduates Enterprise Evaluation Report" to identify three key challenges. The resulting training requirements were defined as: industrial robot debugging techniques, troubleshooting instruction implementation, and quality awareness education integration;

(2) Content implementation and model application:

(i) The enterprise practice module involves deploying 8 professional instructors to industrial robot workshops for 2-month on-the-job training, with technical experts from enterprises serving as mentors. Key training focuses include "robot parameter debugging" and "common fault diagnosis", while HR departments simultaneously explain corporate quality control standards;

(ii) In the "Teaching Transformation Studio", instructors convert enterprise technologies into "industrial robot debugging training projects" and "fault diagnosis simulation cases", incorporating "quality error control" assessment components;

(iii) Enterprise HR specialists conduct "quality awareness seminars", guiding instructors to integrate corporate quality standards into the "Electromechanical Equipment Maintenance" curriculum;

(3) Evaluation Loop: By the end of 202 4, a closed-loop evaluation system will be established through

"process assessment (instructor training reports, teaching transformation plans)", "application evaluation (student training outcomes, classroom feedback)", and "HR feedback evaluation (new graduate assessment data)".

7.3. Pilot results

The "Dual-qualified, Dual-skilled, Dual-capable" initiative has achieved remarkable progress: Among 8 faculty members, 6 obtained the "Industrial Robot Operator Technician" certification (dual-qualification attainment rate increased from 50% to 87.5%); classroom instruction with "job simulation training" rose from 20% to 60% (indicating enhanced teaching quality); 90% of teachers now independently develop enterprise-oriented training programs (dual-capability improvement).

Corporate HR evaluation metrics showed significant improvement: In 2024, graduates "industrial robot debugging proficiency rate" reached 92%, "equipment troubleshooting capability score" improved to 4.6/5, and "quality awareness score" rose to 4.3/5, all meeting corporate HR expectations. The cooperation mechanism between enterprises and schools has been deepened. Pilot enterprises have signed long-term cooperation agreements with the major, and two "teacher practice training bases" have been added. Teachers have been invited to participate in enterprise technical transformation projects, forming a virtuous cycle of "training-practice-cooperation".

8. Conclusions

8.1. Research conclusions

This study focuses on student evaluations of corporate HR professionals. By analyzing existing issues in vocational college teacher training systems and establishing a mapping relationship between HR evaluations and faculty competencies, we ultimately designed an innovative training framework featuring "demand diagnosis, content restructuring, model innovation, and closed-loop evaluation." Through case studies, we validated the systems feasibility and effectiveness.

Student evaluations in enterprise HR programs serve as a critical benchmark for identifying gaps in teachers "dual-qualified, dual-skilled, and dual-capable" competencies. Only by integrating these assessments into the training framework can we address the core issue of "disconnection between training and corporate needs". The training system requires restructuring its content around three key modules: "corporate practice, teaching transformation, and competency integration". Implementing a "dual-mentor system" and a "three-phase training process" will enable precise alignment between faculty capabilities and industry demands. A robust "school-enterprise collaborative management structure, co-built resource system, and incentive-restraint framework" ensures the effective implementation of the training program. Meanwhile, a "four-dimensional dynamic closed-loop evaluation system" remains essential for continuous improvement of training outcomes.

8.2. Research gaps and future directions

8.2.1. shortage of research

The case study is limited to mechatronics, excluding other fields like service industries and IT, and its applicability across disciplines requires further validation. The HR evaluation data primarily comes from small and medium-sized enterprises, with no inclusion of large corporations or multinational companies in the assessment criteria, necessitating an expanded corporate sample range.

8.2.2. Future expectations

Expand the scope of majors and enterprises: Apply the training system to service majors such as logistics management and e-commerce, collect HR evaluation data from different types of enterprises (large state-owned enterprises and foreign-funded enterprises), and optimize the universality of the system.

By integrating digital technologies, we have established a "HR Evaluation-Teacher Training" digital platform that enables automated analysis of evaluation data, intelligent matching of training needs, and real-time tracking of teaching applications, thereby enhancing system operational efficiency. To promote regional adoption, we collaborate with local education authorities and industry associations to transform pilot experiences into standardized vocational teacher training guidelines. This initiative provides practical references for more vocational colleges, supporting the high-quality development of industry-education integration in vocational education.

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Disclosure statement

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Research on the Construction of the "Political Education and Practice" Dual-Integration Model for the Financial Management Major from the Perspective of the Teacher-Student Community

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Abstract

This paper aims to address the dilemma that current financial management teaching fails to meet national policy requirements and the challenges of the times. Based on the characteristics of the financial management major, and taking the teacher-student community as the entry point, it follows the research logic of "goal setting-system construction-implementation path-mechanism guarantee" to innovate the "Political education and practice" dual integration teaching model. It designs a three-dimensional goal system with three dimensions and nine elements under the "Political education and practice" dual integration model; then reconstructs the spiral progressive curriculum modules of "Political education and practice". Based on the teacher-student community, it implements the dual integration model through the paths of role reconstruction, two-way embedding, collaborative practice, and dynamic evaluation. It constructs a guarantee mechanism for the dual integration model through system guarantee, resource integration, and evaluation feedback. Ultimately, it solves the current dilemmas in the teaching of financial management major, helps cultivate high-quality financial management talents with a sense of social responsibility and professional ethics, and provides intellectual support for serving national strategies and industrial development.

Keywords

Dual integration; Ideological and political education; Financial management major; Practice

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1. Introduction

1.1. Problem statement

The educational pattern integrates knowledge education, ability cultivation, and value guidance. The 2025 Government Work Report proposes to accelerate the construction of a high-quality education system, fully implement the project of strengthening moral education and cultivating people in the new era, build a team of high-quality and professional teachers, and improve the talent training model. The Implementation Plan for Deepening the Reform of Education Evaluation in Hunan Province emphasizes the need to build an education evaluation system that guides students to achieve all-round development in moral, intellectual, physical, aesthetic, and labor education. Therefore, under the background of the new era, the financial management major, which undertakes the important task of cultivating high-quality financial management talents, should not only impart professional knowledge and skills but also attach importance to the cultivation of students' professional ethics, sense of social responsibility, and patriotism, so as to achieve the triple goals of "knowledge education, ability cultivation, and value guidance".

The dual background and needs for constructing a teacher-student community in the financial management major. In the digital and intelligent era, although the application of digital and intelligent technologies has brought convenience to higher education, it may also become an inducement for the alienation between teachers and students. Excessive reliance on electronic devices and the Internet has weakened the direct communication and emotional connection between teachers and students. In the current social environment, students majoring in financial management face multiple pressures such as academic studies, employment, and interpersonal relationships, leading to frequent psychological problems, which pose potential threats to the quality of education and social stability. Therefore, constructing a teacher-student community to alleviate students' psychological problems, improve the quality of education, prevent the alienation between teachers and students, and establish a common educational vision and concept is of great significance to professional education.

The urgent need for improvement in the traditional curriculum teaching of financial management major. There are weak points in the integration of ideological and political education in financial management teaching: the integration of ideological and political elements is rigid, lacking systematicness and pertinence, and it is difficult to resonate with students. The teaching model is rigid: teachers mainly adopt the method of "PPT teaching + exercise practice", and students passively accept knowledge. There are difficulties in teacher-student collaboration: the interaction between teachers and students is one-way, students lack subjectivity, and there is a lack of effective interaction and communication between teachers and students. However, the courses of financial management major are characterized by strong practicality and close connection with the economy and society. Therefore, the current teaching situation of financial management major urgently needs to be improved.

To sum up, the traditional teaching model can no longer meet the current policy needs of talent cultivation. In order to actively respond to the challenges of the times, this paper intends to solve the following problems: How to strengthen the emotional connection between teachers and students and improve the quality of higher education through the construction of a teacher-student community? How to innovate the teaching model and organically integrate ideological and political elements into the curriculum teaching of financial management major, so as to achieve the goal of cultivating higher-quality financial management talents?

1.2. Research objectives

Based on the current teaching situation of the financial management major, this paper innovates the "Political education and practice" integrated teaching model for the financial management major from the perspective of the teacher-student community, so as to achieve the goal of cultivating high-quality financial management talents with both moral integrity and professional competence. It solves the problem of weak integration of ideological and political education. With the teacher-student community as the carrier, it explores the path of the "Political education and practice" dual integration model in the courses of financial management major. It reshapes the teacher-student collaborative ecology. Through the mechanism design of the teacher-student community, it breaks the traditional one-way indoctrination teaching model, strengthens the emotional connection and value resonance between teachers and students, and alleviates the dilemma of alienation between teachers and students in the digital and intelligent era. Finally, it responds to the talent needs of the times.

Based on the background of the digital economy and compliance supervision, it meets the core demands of enterprises for financial talents with "both moral integrity and professional competence", promotes the paradigm transformation of financial management professional education from "instrumental rationality" to "value empowerment", and helps realize the organic unity of the fundamental task of "strengthening moral education and cultivating people" and the strategic goal of "high-quality development".

1.3. Research significance

1.3.1. Theoretical significance

By constructing the teacher-student community and the "Political education and practice" dual integration model, this paper breaks through the limitations of the single dimension of traditional financial management teaching research from three dimensions: interdisciplinary integration, dynamic interaction analysis, and practice feeding back theory. It provides a new perspective for the research on the curriculum teaching of financial management major and promotes the deepening and expansion of the disciplinary education theory system.

Through the design of the "Political education and practice" dual integration model, it promotes the transformation of ideological and political education from one-way integration to two-way mutual construction, constructs a theoretical framework of ideological and political education in courses that adapts to the characteristics of financial management major, fills the gap in disciplinary and scenario-based ideological and political research, and provides theoretical reference for the construction of ideological and political education in other professional courses.

This paper applies the concept of the teacher-student community to the construction of ideological and political education in the courses of financial management major, deepens the theoretical research on the teacher-student community, and provides theoretical support for the construction of a new type of teacher-student relationship. It explores the mechanism of the teacher-student community in the "Political education and practice" dual integration model and enriches the theoretical connotation of the teacher-student community.

1.3.2. Practical significance

Through the construction of the dual subjects of teachers and students, it improves teachers' cross-field teaching ability and activates students' subjectivity. With the help of technologies such as virtual simulation and big data, it constructs an "online + offline" teacher-student interaction platform to solve the problem of emotional alienation between teachers and students caused by digital and intelligent tools. This paper provides an operable model reference for the construction of ideological and political education in the courses of financial management major in colleges and universities, and improves the effectiveness of curriculum-based education. It promotes the reform of education and teaching in colleges and universities, innovates the talent training model, and improves the quality of talent cultivation. It provides a talent reserve with both "values and technology" for the compliant operation of enterprises in the digital economy era, reduces the risks of financial fraud and data abuse, and helps the high-quality development of the regional economy.

2. Analysis of domestic and foreign research status

2.1. Concept definition

The definitions are as follows:

(1) Teacher-student community: A new type of teacher-student relationship characterized by "equal dialogue, collaborative innovation, and shared achievements", which emphasizes the linkage between mutual learning and social services;

(2) "Political education and practice" dual integration model: Realizing the in-depth integration of ideological and political education and practice through two-way penetration and dynamic mutual construction; integrating ideological and political elements into practical

teaching, and feeding back practical experience to ideological and political education, so that the two promote each other and develop dynamically.

2.2. Domestic and foreign research status

2.2.1. Research on the integration of ideological and political education into practical teaching of financial management major

Based on recent research, Zhang proposed combining community service with financial management courses, emphasizing the logic of "ability serving value" [1]. Song developed an ethical risk assessment matrix to guide students in quantitatively analyzing the rights and interests of stakeholders in scenarios such as mergers and acquisitions, investment and financing, and promoting the explicit expression of values in practical teaching [2]. Shen designed an online classroom platform, integrating ideological and political goals such as integrity education and social responsibility into financial analysis tasks [3]. Li proposed that the practical courses of financial management need to add a "professional ethics review" module, requiring students to design compliance improvement plans in combination with the Accounting Law and socialist core values, so as to realize the two-way assessment of skills and values [4]. Domestic research focuses on localized practice platforms and ethical review mechanisms, but most of them are limited to the one-way design of "ideological and political integration"; foreign research realizes the symbiosis of values and abilities through service learning and tool development, but lacks in-depth analysis of the particularity of financial management major.

2.2.2. Research on practical feedback to ideological and political education in financial management major

Other than that, Guo advocated the integration of law, sociology, and financial management to promote students to reconstruct the professional knowledge system from a social perspective [5]. Li proposed introducing real enterprise projects into the classroom, requiring students to complete a Social Responsibility Report while solving practical problems, so as to realize the closed loop of "practice feeding back values" [6]. Geng used virtual simulation technology to simulate financial decision-making scenarios, analyzed students' value tendencies by recording their operation data, and dynamically adjusted the teaching content [7]. Domestic research explores the path of practical feedback to ideological and political education through school-enterprise cooperation and cultural resource integration, but has not yet formed a systematic feedback mechanism; foreign research focuses on reflection and interdisciplinary integration, but has insufficient application of local cultural resources, making it difficult to adapt to the financial management needs with Chinese characteristics.

2.2.3. Research on teaching reform of financial management major from the perspective of teacher-student community

Furthermore, Hao pointed out that the teacher-student community needs to realize "legitimate peripheral participation" [8]. For example, junior students follow senior teams to participate in enterprise audit projects, and gradually internalize professional norms and social responsibilities in collaboration. Gu critical pedagogy emphasizes breaking the authority of teachers, allowing students to take the lead in designing ethical review standards, and turning teachers into collaborative consultants [9]. Wang *et al.* proposed the "dual tutor system" of "ideological and political tutor + practical tutor", realizing the two-way penetration of values and skills through the joint compilation of case databases by teachers and students [10]. Chen proposed the establishment of a teacher-student ethical decision-making workshop, regularly reviewing conflict cases in practice, and forming an iterative teaching plan through teacher-student debates and expert intervention [11]. Domestic research promotes teacher-student interaction through the dual tutor system and workshops, but has insufficient research on the dynamic evolution mechanism of the community; foreign theories emphasize equal collaboration, but lack targeted design for the complex interest conflict scenarios of financial management major.

2.2.4. Research review

In summary, the existing domestic and foreign research remains at the level of one-way impact research between ideological and political education and practice. Most scholars focus on how to integrate values into practical tasks, and a small number of scholars study how practice feeds back to values, but no systematic mechanism has been formed. The research on the two-way impact between the two is almost blank, and the research on the dual integration model of ideological and political education and practice in financial management major from the perspective of the teacher-student community is even scarcer. The above deficiencies leave sufficient research space and necessity for this paper, which is not only the academic history basis for the topic selection of this project but also the academic premise and starting point of this paper.

3. Innovating the implementation path of the "political education and practice" dual integration model from the perspective of the teacher-student community

To innovate the implementation path of the "Political education and practice" dual integration model from the perspective of the teacher-student community, it is essential to take the equal participation and collaborative progress of teachers and students as the core. Through role reconstruction, two-way embedding, collaborative practice, and dynamic evaluation, we can address the dilemma of insufficient teacher-student interaction and achieve the two-way empowerment of teachers and students' common growth and social services.

3.1. Reconstructing the role orientation of teachers and students

Teachers, acting as guides and collaborative practitioners, jointly design curriculum frameworks and practical themes with students, respecting students' subjectivity. Students transform from passive recipients of knowledge to active constructors: by participating in social practice, case analysis, project design, and other activities, they put forward personalized insights that in turn feed back into the classroom.

3.2. Jointly building the learning field by teachers and students: Two-way embedding of curriculum and practice

Teachers and students work together to identify social hot topics as practical research themes, transforming ideological and political theories into solutions to real-world problems. In addition, they could jointly plan and participate in red-study tours, rural revitalization surveys, and other activities, deepening their theoretical understanding through practice.

3.3. Jointly undertaking responsibilities and sharing achievements by teachers and students' collaborative practical projects

A project-driven approach can be adopted to strengthen collaborative innovation between teachers and students. Joint research topics may be established and teacher-student innovation teams formed, enabling the integration of ideological and political elements into innovation and entrepreneurship projects and thereby achieving both value guidance and competency development. In parallel, mechanisms for achievement sharing and transformation should be implemented, such as coauthoring practical reports, publishing research outcomes, or disseminating project results through new media, including short videos and institutional WeChat accounts, to expand social influence. To support continuous improvement, a dynamic teacher-student evaluation system may be introduced. This includes a "dual-journal" mechanism that facilitates regular mutual evaluation and feedback between teachers and students; a multidimensional competency radar chart to track indicators such as social responsibility, teamwork, and problem-solving ability, thus avoiding one-dimensional score-based assessment; and a visual dynamic dashboard that displays real-time progress of practical activities, competency growth trajectories, and social feedback metrics, providing data-driven support for refining instructional strategies.

Through the above dynamic evaluation mechanism, evaluation is integrated into the growth process of the teacher-student community, truly realizing the in-depth integration of ideological and political education and practical education.

3.4. Constructing the guarantee mechanism for the "political education and practice" dual integration model from the perspective of the teacher-student community

The guarantee mechanism provides comprehensive support in terms of systems, resources, and evaluation for the sustainable operation of the teacher-student community and the iterative optimization of the "Political education and practice" dual integration model. For instance:

(1) System guarantee mechanism (Implement the "Dual-Teacher and Three-Mentor" system): Each core course is assigned a professional teacher, an ideological and political mentor, and an enterprise mentor to form a collaborative education team. Establish a linkage mechanism of "enterprise needs - policy changes - curriculum updates" to dynamically adjust curriculum content annually in line with policy requirements and enterprise needs;

(2) Resource integration mechanism: Integrate school-enterprise resources to jointly build a "Political education and practice" case database and digital platform, and establish a school-enterprise-government cooperation platform and invite industry experts to participate in curriculum design;

(3) Evaluation and feedback mechanism

- (i) Multi-subject participation: Enterprise representatives and heads of practical bases score the practical achievements of teachers and students, strengthening the practical value orientation of ideological and political education;
- (ii) Multi-dimensional evaluation system: Cover both process-oriented ethical performance and result-oriented social contributions, with additional dimensions for ideological and political education and practical skills.

4. Conclusion

To address the current practical dilemmas in financial management teaching, such as the weak integration of ideological and political elements and rigid teaching models, this paper proposes a dual integration teaching model that achieves two-way integration of ideological and political education and practice. The key to this teaching model lies in realizing the "genetic recombination" of ideological and political education and practice, which requires the deconstruction and reconstruction of elements related to both ideological and political education and practice. Reconstructing the curriculum system is the starting point, but the key to the implementation of the curriculum system lies in teaching. The effectiveness of teaching mainly depends on the two core subjects of education: teachers and students. However, the current dilemma of insufficient teacher-student collaboration in colleges and universities hinders the high-quality development of education and will inevitably affect the implementation of the dual integration model. Therefore, the key issue to be addressed is: how to build the implementation path of the dual integration model based on the teacher-student community, implement the "Political education and practice" dual integration teaching model for the financial management major, and ultimately realize a new education ecosystem characterized by collaborative progress.

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A Study on Strategies for Developing Vocational English Competence in Applied Universities Based on Core Competencies

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Abstract

With the deepening of global economic integration, China's industrial upgrading and economic restructuring have created an urgent demand for high-quality applied professionals. As the primary force in cultivating frontline technical and skilled personnel, applied universities now face a critical challenge: graduates' professional English proficiency has become a key indicator of their international competitiveness and career development potential. However, many applied universities still struggle with issues such as disconnection between English instruction and professional practice, outdated teaching models, and monolithic evaluation systems, which fail to meet the practical needs of society and enterprises. This study aims to thoroughly analyze the current status and challenges of professional English education in applied universities, while exploring competency-based strategies for cultivating applied English skills. The research seeks to provide theoretical references and practical solutions for achieving deep integration of "English proficiency" and "professional competence," ultimately fostering internationally-oriented applied talents that meet the demands of the new era.

Keywords

Ability development; Applied universities; Industry-education integration; Innovative approaches; Vocational English

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1. Introduction

The educational positioning of applied universities dictates that their talent cultivation must prioritize serving regional socio-economic development while focusing on students 'employability and career advancement. Distinct from traditional general English (English for General Purposes, EGP), English for Occupational Purposes (EOP) refers to students' practical ability to use English effectively in specific professional scenarios for communication and task completion [1]. Covering three dimensions, language skills, professional knowledge, and vocational competence, EOP serves as a "passport" enabling students to broaden international perspectives, engage in global collaboration, and excel in cross-cultural roles [2].

However, current English education in applied universities faces severe challenges: persistent criticisms of "time-consuming and inefficient" teaching methods, widespread student confusion about "learning without practical application," and corporate complaints about graduates' "mute English" and "inability to comprehend specialized English" [3]. This supply-demand imbalance highlights the limitations of traditional teaching models, making vocational competency-oriented reforms urgently needed. Against this backdrop, this study explores an innovative cultivation pathway that effectively bridges classroom learning with workplace demands, seamlessly connecting knowledge acquisition with practical skill development.

2. Practical difficulties in cultivating vocational English ability in applied universities

2.1. The teaching objectives are vague and disconnected from the professional needs

Many institutions' vocational English programs merely extend general English instruction without delving into specific workflows and typical communication tasks across disciplines such as smart manufacturing, international business, hospitality management, and cross-border e-commerce [4]. The teaching objectives are vaguely defined as "passing proficiency tests" rather than "completing workplace tasks," resulting in content that lacks professional relevance and practicality.

2.2. The curriculum system is rigid and the practical link is weak

Curriculum design predominantly emphasizes theoretical instruction, with textbooks that update slowly, lagging behind industry advancements and real-world workplace dynamics [5]. The lack of sufficient project-based, case study, and simulation components in practical teaching hinders students from gaining experience in applying English to solve real-world problems within authentic or simulated professional environments.

2.3. The teaching mode is traditional and the subjectivity of students is missing

Classroom teaching remains teacher-centered, with grammar and vocabulary explanations dominating the session, resulting in a typical 'one-man show' scenario. This one-way teaching approach neglects students' initiative, failing to effectively develop core professional competencies such as self-directed learning, teamwork, and intercultural communication. The classroom atmosphere becomes monotonous, and learning outcomes remain suboptimal [6].

2.4. The structure of the teaching staff is monotonous, and the quality of "double teachers" is lacking

While most English teachers possess strong language and literary foundations, they generally lack industry experience and practical workplace exposure, making it challenging for them to accurately grasp the specific English application requirements across different professional fields. Meanwhile, although subject teachers are well-versed in their disciplines, their English teaching proficiency often falls short, resulting in a disconnect between language instruction and professional education [7].

2.5. The evaluation mechanism is one-sided and ignores the process and application

The current teaching evaluation system overemphasizes a single final exam, primarily assessing students 'memorization of language knowledge points (vocabulary and grammar) rather than their practical language application skills and project performance. This one-dimensional, summative evaluation method fails to comprehensively and objectively measure students' comprehensive professional English competencies, instead creating a negative feedback effect (washback effect) [8].

3. Strategies for cultivating vocational English competence in application-oriented universities based on core competencies

In view of the above difficulties, applied universities must carry out a systematic reform and build an innovative training system with "competency-oriented, output-oriented and industry-education integration" as the core.

3.1. Reconstructing the goal system: From 'language-oriented' to 'career competency-oriented'

The core premise of reforming vocational English education in applied universities lies in completely transcending the framework of traditional general English instruction, achieving a fundamental shift from emphasizing language knowledge transmission to focusing on cultivating comprehensive vocational competencies [9]. This transformation does not negate language fundamentals, but rather emphasizes that language must serve as a tool for real-world professional tasks and scenarios, ultimately aiming to equip students with effective communication and problem-solving capabilities in international work environments. For a long time, there has been a significant disconnect between vocational English education and professional demands, with teaching objectives often vaguely defined as "improving English proficiency" or "passing certification exams." This has led to students feeling overwhelmed even when mastering extensive vocabulary and grammar rules when encountering technical documents in specialized fields, international business communications, or cross-cultural collaborations. Therefore, the primary task in reconstructing the goal system is to break down barriers between English education and professional training, driving a strategic transformation from "teaching for language" to "using for careers" [10].

Achieving this transformation requires establishing a collaborative innovation mechanism. Universities should take the lead in forming a teaching advisory committee composed of English instructors, core faculty members, and industry experts from partner enterprises. The committee's primary function is to conduct systematic and in-depth industry research and job competency analysis, focusing on regional key industries and the university's core academic clusters. This enables precise identification of English communication tasks and competency requirements for graduates 'future positions. For example, for the Intelligent Manufacturing program, it's essential to analyze whether job roles involve reading English technical manuals, operating imported equipment interfaces, or participating in international technical training. For the International Business program, it's crucial to clarify whether tasks include drafting English business correspondence, preparing cross-border cooperation agreements, or conducting overseas market sentiment analysis. Through these analyses, the vague concept of "English proficiency" can be transformed into a series of specific, observable, and measurable "professional action competencies".

3.2. Curriculum refinement: Transitioning from 'general textbooks' to 'project-based modules'

A major obstacle in traditional vocational English education stems from excessive reliance on standardized textbooks. These materials predominantly focus on daily conversations and generic topics, lacking strong connections to specific workplace contexts across different disciplines. This disconnect makes it difficult for students to effectively apply their language skills in future careers. To address this challenge, we must fundamentally optimize curriculum design by breaking free from textbook constraints and developing modular, project-based teaching content aligned with real-world work processes. This optimization doesn't discard foundational language knowledge but rather restructures and integrates it into simulated, meaningful professional activities.

This approach stimulates students' intrinsic motivation and achieves immediate integration of "learning" and "application." Specifically, curriculum development should abandon the traditional organization method based on grammar units or functional topics, instead adopting core carriers like typical professional tasks, complete work projects, or real corporate cases specific to each discipline. This means teaching content evolves from isolated texts or mechanical exercises into comprehensive challenges requiring students to apply integrated skills. For instance, for tourism management majors, a comprehensive project titled "Planning and Promoting a Silk Road Cultural Heritage Premium Tourism Route for European and American Tourists" could be designed.

In this project, students complete a series of modular tasks: To gather information, they must read and comprehend English historical documents and official tourist site introductions (developing professional reading skills); For route design, they need to discuss in groups and draft English itinerary plans, strategically arranging transportation, accommodations, and attractions (enhancing written communication and logical planning abilities); For promotional simulations, they record English tour guide videos or conduct live streams (improving oral expression and new media skills); To handle client inquiries, they simulate email responses addressing various issues like itinerary changes and special dietary requirements (cultivating intercultural communication and adaptability). Each module seamlessly integrates language skills, professional knowledge, and workplace ethics, allowing students to naturally absorb and apply language proficiency throughout the project process.

3.3. Innovative teaching models and methods: From "teacher-centered" to "student-centered"

To achieve fundamental transformation in cultivating vocational English competencies at applied universities, we must completely abandon the traditional teacher-centered teaching model dominated by one-way knowledge transfer, and fully implement a student-centered teaching philosophy. The core of this philosophy lies in truly returning the classroom's primary role to students, emphasizing their active construction of knowledge and development of skills through authentic, meaningful language practice activities. Teachers' roles should shift from being authoritative knowledge transmitters to becoming guides, designers, and supporters in the learning process. To realize this transformation, modern teaching methods such as Task-Based Language Teaching (TBLT), Project-Based Learning (PBL), situational simulation teaching, and case-based instruction should be widely adopted. These methods collectively focus on enabling students to "learn by doing" and "learn through application," allowing them to comprehensively utilize English to solve practical problems by completing tasks and projects closely aligned with professional realities. This approach effectively promotes the coordinated development of language proficiency, vocational competence, and critical thinking.

In practical implementation, the primary initiative involves leveraging modern educational technologies to create highly simulated international professional scenarios. Educators can utilize virtual reality (VR), augmented reality (AR) technologies, and smart classroom facilities to develop virtual environments such as simulated international trade fairs, cross-border e-commerce negotiations, overseas customer service call centers, and international academic conferences. Students can "immerse" themselves in these scenarios through wearable devices or interactive terminals, assuming various roles, such as foreign trade sales representatives, exhibition interpreters, and international project managers, to complete a series of tasks ranging from product presentations and contract negotiations to dispute resolution.

The development of a blended learning model that deeply integrates online and offline education is the key pathway to supporting student-centered classrooms. Online, teachers should fully utilize platforms like SPOC (Small Private Online Course), Chaoxing Learning Hub, and Zhihuishu to build digital resource libraries aligned with courses. These resources should include micro-lecture videos focusing on key language knowledge, real-world industry case studies, commonly used business language corpora, and international business etiquette animation libraries. Students can independently complete online learning and initial exercises based on their own foundation and progress. The data analysis features of these platforms also help teachers accurately identify common learning difficulties and individual differences. This approach "liberates" offline classroom time, freeing it from inefficient knowledge delivery to focus on cultivating higher-order competencies. Teachers design collaborative inquiry tasks based on real-world problems, organizing group discussions, solution design, debates, and presentation activities.

Ultimately, systematically designing and promoting collaborative learning proves essential, as it mirrors the team dynamics of future workplaces. Educators should craft extended group projects, such as developing a fully English-language international marketing strategy for a domestic sports brand entering global markets. During implementation, students autonomously divide roles (e.g., market researcher, copywriter, visual designer, final presenter) while navigating the entire process: data collection, concept development, content creation, rehearsal refinement, and final presentation. Through this process, students not only hone their English reading, writing, and translation skills but also gain hands-on experience in communication, compromise, leadership, and accountability through authentic teamwork.

3.4. Reforming the evaluation mechanism: from "single test paper" to "multiple assessment"

Educational assessment serves as the "guiding rod" for teaching reform, with its orientation and methods directly influencing how teachers instruct and students learn. The traditional vocational English evaluation system over-relied on final written exams, emphasizing mechanical memorization of language knowledge and grammatical accuracy while severely neglecting students 'comprehensive ability to apply English in real-world professional scenarios. This "one exam determines everything" approach fails to effectively measure students' communication skills, teamwork spirit, innovative thinking, and professional competence. It even creates a negative feedback loop in teaching, keeping the focus stuck on exam-oriented training. Therefore, we must fundamentally reconstruct the evaluation system by establishing a diversified and developmental assessment mechanism that combines "process evaluation with summative evaluation, and equally emphasizes competency assessment and knowledge assessment." This will truly transform it into a powerful tool for promoting students' comprehensive ability development.

The defining characteristic of a comprehensive evaluation system lies in its expanded and restructured assessment criteria. This requires shifting focus from the narrow metric of "language accuracy" to broader workplace-oriented "task completion quality". When designing evaluation standards, teachers should prioritize not only lexical and grammatical precision but also: task completion effectiveness, whether students can successfully achieve professional objectives (e.g., delivering a product pitch or drafting a standardized business report); communication effectiveness encompassing fluency, logical coherence, appropriateness, and cross-cultural adaptability; teamwork skills including contribution, role-playing, conflict resolution, and leadership in group projects; and solution innovation that demonstrates critical thinking and creative problem-solving. For instance, when evaluating a project titled "Developing an English Marketing Strategy for New Product in Overseas Social Media", assessment criteria extend beyond grammatically correct copywriting to include precise target audience engagement, creative communication strategies, implementability, and efficient team collaboration.

To effectively assess these competencies, we must innovate evaluation formats and methods, moving beyond the dominance of written tests. This requires developing a comprehensive system that integrates multiple assessment tools as outlined:

(1) Project report and portfolio: Students compile a collection of process documents and final outcomes for a complete project, enabling teachers to evaluate their comprehensive capabilities in research, design, execution, and reflection;

(2) Oral presentation and simulation: Through simulated press conferences, business negotiations, customer service and other scenarios, the oral expression, adaptability and professional demeanor are evaluated visually;

(3) Practical operation: In the computer room or training room, the practical skills such as operating cross-border e-commerce platform, processing English orders and making English promotion materials are assessed directly;

(4) Cooperative evaluation: introduce group mutual evaluation and student self-evaluation to cultivate students' metacognitive ability, and invite enterprise mentors or industry experts to comment on the project results to inject industrial perspective.

This kind of diversified evaluation form is not only more comprehensive and fair, but also a valuable learning experience in itself, which guides students to pay attention to the improvement of ability rather than the score itself.

Furthermore, actively adopting third-party certifications with social recognition serves as a vital strategy to bridge academic education with the external labor market while enhancing the objectivity and credibility of talent evaluation. Educational institutions should establish a "course-certification integration" mechanism, encouraging and guiding students to obtain internationally recognized professional English certifications closely aligned with their academic disciplines. For instance, students majoring in

International Trade could be motivated to prepare for the TOEIC test to demonstrate their English proficiency in global work environments. Those in Secretarial or Administrative Management programs may effectively assess their workplace English application skills through the BULATS certification. For students specializing in Cross-border E-commerce, obtaining professional certifications like the Alibaba Cross-border E-commerce Operator Certificate provides authoritative endorsement of their platform operation and English digital marketing capabilities. Integrating these certification standards and content into daily teaching and evaluation systems not only sets clear learning objectives for students but also validates teaching quality through pass rates. This approach significantly enhances graduates' competitiveness and confidence in the job market, ensuring their competencies receive direct societal recognition.

4. Conclusion

To ensure the effective implementation of competency-based vocational English training strategies in applied universities, institutions must provide support through top-level design, resource allocation, and policy guarantees. Schools should establish clear reform roadmaps, increase investments in smart teaching environments, simulation training labs, and industry-academia collaboration platforms, while improving faculty evaluation and incentive mechanisms to encourage teaching innovation. Looking ahead, vocational English education in applied universities must steadfastly pursue industry-education integration and work-study integration. It should evolve from an isolated language course into a deeply embedded component of talent development, serving as a crucial enabler for students' career advancement. Through systematic innovation and reform, we will cultivate new-era applied talents who master professional skills while possessing exceptional international communication capabilities, providing solid talent support for national strategies and regional economic development.

Disclosure statement

The author declares no conflict of interest.

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