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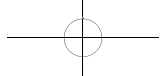
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Education Reform and Development

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Educational Reform and Development is a peer-reviewed, open-access international professional academic journal. The column of *Educational Reform and Development* includes comments, basic researches, literature reviews and research letters. Manuscripts should be scientifically advanced, readable and practical, with prominent points, concise words, reliable data, standard writing and accurate expression. The main readers of this journal are principals, teachers, education administrators, education researchers, and domestic and foreign researchers concerned with adolescent education.

Education Reform and Development mainly reflects the latest development and scientific research achievements of education, explores the rules of education, promotes academic exchanges at home and abroad, and serves for deepening educational reform and prospering educational science.

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Research on the Cultivation of Undergraduates' Professional Core Competencies through Industry-Education Integration in the Digital-Intelligent Era

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Abstract: This study centers on the Automation (Robotics) program at Information Engineering College, Hangzhou Dianzi University, addressing four critical gaps in traditional integration models amid the digital-intelligent era: vague definitions of core competencies, underdeveloped integration mechanisms, suboptimal talent development strategies, and barriers to scaling practical outcomes. Through systematic inquiry into integration frameworks and talent cultivation pathways, the research establishes a core competency framework tailored to digital-age Automation (Robotics) programs, dissects the internal dynamics of how industry-education partnerships drive capability building, and designs implementable talent development solutions. Ultimately, it delivers replicable practical paradigms and theoretical frameworks. These findings not only support the Information Engineering College, Hangzhou Dianzi University of Science and Technology in refining its talent pipeline and boosting program competitiveness but also offer actionable insights and theoretical guidance for institutions nationwide seeking to advance industry-education collaboration and prepare Automation (Robotics) professionals.

Keywords: Six Four; Curriculum system; A pedagogical study

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1. Introduction

Driven by national strategies and industry demands, industry-education integration has become a backbone of education-industry collaboration, fueling economic and social progress^[1]. Policy momentum has built steadily since 2010, when the National Medium- and Long-Term Education Reform Plan first institutionalized school-enterprise partnerships; subsequent documents (2013–2019) formalized integration, aligned it with “education-talent-industry-innovation chains,” and post-20th CPC National Congress, policies like the Management Measures for Industry-Part-Time Teachers and Outline for a Strong Education Nation, have accelerated efforts

to boost enterprise engagement, diversify faculty, and deepen university-enterprise collaboration, with a focus on linking education, science, tech, and talent for global competitiveness^[2,3].

On the practical front, tangible results include 2022's push for "industry-education integration communities" in high-priority sectors (next-gen IT, robotics) and the 2023 launch of China's first national community (rail transit, Changzhou), which spans 22 provinces and 97 members, delivering wins in skilled talent training and tech problem-solving^[4]. Yet challenges persist: enterprises hesitate due to high costs and slow returns, universities offer outdated, theory-heavy curricula (leaving engineering graduates with long adaptation periods), and integration lacks clear communication, benefit-sharing, or feedback systems^[5,6].

Internationally, models like Germany's enterprise-led dual system (e.g., Schindler's tailored training), the U.S. cooperative education (alternating study and internships), and Australia's industry-driven TAFE system offer lessons, with three global trends resonating with U.S. priorities: interdisciplinary collaboration to build versatile skills, lifelong learning for professionals via corporate training, and global cooperation (multinational training centers) to cultivate internationally competitive talent^[7-9].

As a key institution for Automation (Robotics) talent cultivation, Hangzhou Dianzi University of Science and Technology (HDUST) can pinpoint the digital-intelligent era's diverse industry demands via this research.^[10-12] It can then optimize curricula by integrating cutting-edge technologies—AI in robot visual recognition/decision systems, industrial internet-robot integration, and robot operating systems—to ensure timeliness and practicality, while innovating teaching methods (project-based learning, case teaching, hybrid models, engineer assistants) and strengthening practical courses to boost students' hands-on skills. Further refining the talent program (from enrollment to graduation assessment) to align with industry needs will enhance talent-industry matching. These steps will improve HDUST's cultivation quality, competitiveness among peers, and overall system, while offering national references for universities to advance industry-education integration, deepen corporate collaboration, and build an open, innovative ecosystem for fostering application-oriented talents.

Based in Qingshanhu Sci-Tech City (Hangzhou's West Sci-Tech Corridor), HDUST addresses the local robotics industry's critical digital-intelligent transformation and severe core-talent shortage. This research cultivates Automation (Robotics) talents with solid knowledge, practical skills, and innovation—talents that meet local industrial needs, ease shortages, and drive industry upgrading. HDUST's industry-education integration practices (well-designed theory-practice curricula, hands-on project platforms, innovative university-enterprise cooperation) provide a complete, actionable template for similar majors. Sharing these achievements via academic channels will update national talent cultivation concepts for Automation (Robotics) and engineering majors, supply high-quality talent to the industry, and propel its sustainable, high-quality development in the digital-intelligent era.

2. Research questions

2.1 Ambiguity in defining core competencies for automation (robotics) majors in the digital-intelligent era

- (1) How to accurately map the development trajectory of the automation (robotics) industry in the digital-intelligent era, and identify the practical, comprehensive core competency requirements that the industry imposes on undergraduates, specifically in areas like programming algorithms, intelligent

control, data analysis, and interdisciplinary integration?

- (2) How to develop a clear, comprehensive, and era-specific multi-dimensional core competency framework (encompassing knowledge reserves, skill application, and professional literacy) through effective methods, such as in-depth interviews with senior industry experts and analysis of job descriptions from leading enterprises?
- (3) How to combine literature reviews and case studies to pinpoint the specific changes in core competencies brought by emerging technologies in the digital-intelligent era, compared to traditional automation programs, such as the need to master robots' autonomous learning capabilities or new requirements for industrial internet system operation and maintenance? This clarity will provide clear guidance for talent cultivation.

2.2. Unclear mechanisms for enhancing core competencies driven by industry-education integration

- (1) What research methods (e.g., questionnaires, on-site investigations, in-depth corporate interviews) can fully and deeply capture the existing industry-education integration models of HDUST's Automation (Robotics) major, including collaboration methods, resource investment scales, and two-way interaction mechanisms in curriculum co-development, internship training base construction, and joint research projects between enterprises and the university?
- (2) Based on empirical research, how to explore the specific pathways through which each link of industry-education integration enhances undergraduates' core competencies? This should involve tracking data (e.g., academic performance, practical project outcomes, professional competency assessments) of students participating in industry-education integration programs.
- (3) What tools (e.g., structural equation modeling) can accurately identify key factors influencing core competency improvement, such as the complexity of corporate practical projects or the alignment between university theoretical teaching and enterprise practice, to reveal the internal logic of how industry-education integration drives the development of students' professional core competencies?

2.3 Lack of optimized talent cultivation programs for industry-education integration

- (1) Based on the core competency requirements and enhancement mechanisms identified in previous research, how to design a systematic, feasible, optimized industry-education integration talent cultivation program (covering curriculum reform, practical teaching innovation, and deepened university-enterprise collaboration) that aligns with actual conditions (e.g., faculty strength, teaching resources, institutional characteristics)? For example, how to reasonably add courses on cutting-edge digital-intelligent technologies or robot system integration practice in curriculum reform? How to build a scientific, progressive, practical teaching system ("on-campus simulation → enterprise internships → innovation/entrepreneurship practice") in practical teaching innovation? How to establish an effective system for corporate mentors to participate in the entire talent cultivation process in deepened university-enterprise collaboration?
- (2) How to select an appropriate number of classes as pilot groups, set up control groups, and use mixed quantitative-qualitative evaluation methods (collecting data on academic performance, practical competency assessments, and corporate feedback) to effectively evaluate the effectiveness and

feasibility of the optimized program in enhancing undergraduates' core competencies?

- (3) How to use educational statistics software to conduct in-depth analysis of collected data, and dynamically adjust and refine the optimized program based on evaluation results, laying a solid foundation for its wide promotion and application?

2.4. Difficulties in summarizing practical experience and promoting achievements

- (1) How to comprehensively summarize the practical experience of HDUST's Automation (Robotics) major in enhancing undergraduates' competencies through industry-education integration in the digital-intelligent era, including successful collaboration models, effective teaching methods, and sound management mechanisms?
- (2) Using case analysis and experience synthesis, how can to refine these practical achievements into replicable, promotable practical models and operational guidelines (covering the entire process from talent cultivation goal-setting to teaching quality evaluation)?
- (3) When promoting research achievements to other domestic universities (Robotics) and related engineering majors (via academic seminars, research report releases, or inter-university exchanges), how can an effective feedback mechanism be established for achievement application?

This mechanism should collect feedback on application effects from other universities to continuously optimize practical models and operational guidelines, ultimately helping improve talent cultivation quality in relevant majors nationwide and driving the overall development of the industry.

3. Solutions

3.1. The talent development objectives for Hangzhou Telecom Engineering Automation (Robotics) have been established

The talent cultivation goal for the Automation (Robotics) major at Hangzhou Dianzi University of Science and Technology (HDUST) has been defined, with the formation of an educational objective centered on the core philosophy of “fostering virtue through education” (Lide Shuren). By setting curriculum objectives, this goal is implemented from four dimensions: knowledge objectives, competence objectives, literacy objectives, and value objectives.

As shown in **Table 1**, the approach of “cultivating four key capabilities through four core attributes” and “achieving four expected outcomes through four transformative measures” is adopted. This approach highly aligns with the new requirements for student learning and teacher development in the new era, enabling students to: understand curriculum content, adapt to curriculum reforms, innovate curriculum practices, and comprehend evaluation standards.

On this basis, the strategy of “nurturing four types of aspirations through four dimensions” is implemented. Educational elements are explored from four perspectives: commonality, individuality, content, and methodology, to construct a full-process ideological and political education chain integrated into curricula. Ultimately, this cultivates students' innovative awareness, critical thinking, and patriotic spirit.

Table 1. The “Six Four” education chain

| Six Four | Education Chain |
|--------------------------------------|---|
| Four Properties | Fun, inspiring, systematic, and practical |
| Four abilities | Identify, raise, analyze, and solve problems |
| Four Changes | Change in concept, change in role, change in method, change in evaluation |
| quadruple effect | The effectiveness of university education, innovative classroom practices, deep-rooted educational outcomes, and direct improvements in quality |
| four-dimensional, of four dimensions | Common dimension, individual dimension, content dimension, method dimension |
| Four Loves | Love the motherland, the Party, the people and socialism |

3.2. Curriculum system

To accurately align with enterprise demands in the digital era, we are restructuring our curriculum system by prioritizing the integration of additional digital-intelligence course modules and practical training programs. As technological iteration accelerates, the market has imposed brand-new requirements on talent capabilities. Based on in-depth reflections on the talent cultivation objectives of automation (robotics) programs, application-oriented universities and insights from industry research, reforming the core competency development system for undergraduate students majoring in Automation (Robotics) at Hangzhou Dianzi University Information Engineering College (hereafter referred to as “HDU-IE”) through industry-education integration has become an inevitable strategic choice in the digital age.

This reform will be anchored in cutting-edge concepts such as artificial intelligence, large models, and big data. It will break down traditional disciplinary silos, systematically integrate knowledge across multiple fields—including mechanical engineering, electronic information, and computer science—and structure the curriculum content into three hierarchical tiers: foundational, advanced, and high-level. Meanwhile, by leveraging advanced information technologies, we will conduct a comprehensive optimization and upgrading of the overall teaching system for the Automation (Robotics) program.

We are actively advancing the in-depth integration of three key elements: automation education in the digital era, intelligent manufacturing technologies, and real-world enterprise projects. This integration aims to establish a core curriculum system characterized by “interdisciplinary integration and multi-domain connectivity.” Centered on the framework of “Automation (Robotics) Technology + Artificial Intelligence + Engineering Applications” (**Figure 1**), the system focuses on fostering students’ core competencies in three critical areas:

- (1) Robot programming and control;
- (2) Intelligent perception and decision-making;
- (3) Automation system integration.

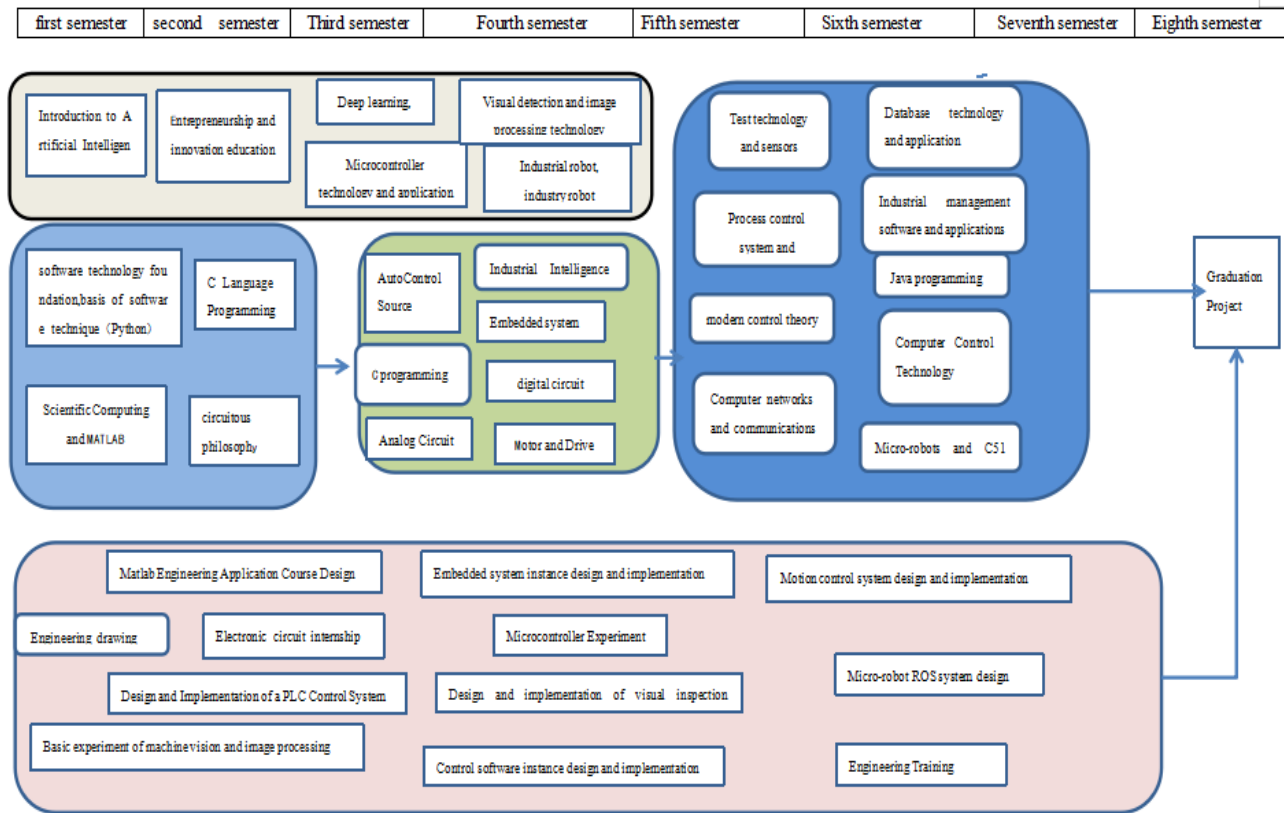


Figure 1. Curriculum system.

These competencies will ensure that graduates can precisely meet the industrial development needs of the digital-intelligence era, ultimately growing into high-caliber professionals who possess both a solid theoretical foundation and strong practical application abilities.

3.3. Construct an automated (Robotics) professional training base

- (1) Construct and improve the on-campus practical teaching platform. Integrate the resources of on-campus laboratories related to the automation major to build a fully functional and advanced-equipped robot practical teaching platform.
- (2) Upgrade and transform the basic experimental teaching center, and equip it with sufficient basic experimental equipment for robots, such as robot model kits, simple motion control experimental platforms, sensor experiment boxes, etc., to meet students' needs for learning basic knowledge of robots and training basic skills.
- (3) Build a professional comprehensive laboratory, introduce high-end equipment such as industrial-grade robot equipment, robot control system development platforms, and machine vision systems, and provide students with an experimental environment for comprehensive practical projects such as robot system integration, intelligent control algorithm development, and visual applications.
- (4) Establish an innovative practical laboratory, equip it with innovative tools and equipment such as 3D printers, laser cutters, and open-source hardware platforms, and provide support for students to carry out innovative robot design and R&D activities, as shown in **Figure 2**.



Figure 2. Partial on-campus experimental platforms.

- (5) Optimize the on-campus practical teaching curriculum system. According to the construction situation of the robot practical teaching platform, develop a series of targeted and systematic practical courses, including courses at different levels such as basic robot experimental courses, professional core practical courses, and innovative practical courses.
- (6) Construct a practical teaching curriculum system that ranges from basic to comprehensive, from theory to practice, and from imitation to innovation, so that students can obtain corresponding practical training in different stages of learning and gradually improve their practical ability and innovation level.

3.4. Expanding off-campus Industry-University-Research (IUR) cooperation resources

- (1) Expand off-campus IUR cooperation resources. Establish extensive and in-depth IUR cooperative relationships with well-known enterprises and research institutions in the robotics industry to further expand off-campus practical teaching resources.
- (2) Set up several stable enterprise internship bases, jointly develop internship plans and implementation programs with enterprises, and arrange for students to participate in internships in different departments of enterprises, such as R&D, production, sales, and after-sales service. Through this initiative, it helps students gain an in-depth understanding of the actual workflow and market demands of the robotics industry and accumulate engineering practice experience.
- (3) Carry out IUR cooperation projects, and jointly undertake scientific research topics, technology R&D tasks, and product innovation projects in the field of robotics with enterprises and research institutions. This initiative not only promotes the transformation and application of the school's scientific research achievements but also provides students with opportunities to participate in practical scientific research projects, thereby enhancing their scientific research innovation capabilities and practical application abilities.
- (4) Jointly build a robotics industry college with enterprises, industry associations, and other parties, integrate resources from all sides, and carry out all-round cooperation in the fields of talent cultivation, scientific research, technical services, and innovation and entrepreneurship, to create an

integrated collaborative education platform featuring “integration of industry, university, research and application.”

- (5) Establishing an Off-Campus Practical Teaching Resource Sharing Mechanism. Establish an off-campus practical teaching resource sharing mechanism to strengthen exchanges and cooperation between the school, enterprises research institutions in terms of practical teaching resources. The specific measures are as follows:
- (A) Invite corporate engineers to the campus to carry out activities such as practical teaching lectures and technical training, sharing the enterprise’s practical experience and the latest technological trends in the industry;
 - (B) The school opens part of its laboratory resources to enterprises, providing opportunities for enterprise employees to receive technical training and continuing education;
 - (C) Establish a practical teaching case database and resource library, collect and organize resources such as enterprise practical project cases and engineering technical materials, for teachers and students of the school to use in the teaching and learning process.

Through the above measures, the complementary advantages of on-campus and off-campus practical teaching resources are realized, and the goals of resource sharing and win-win cooperation are achieved.

3.5. University-enterprise joint evaluation: Building a diversified and multi-dimensional talent cultivation evaluation mechanism for long-term evaluation and feedback

In the past, the evaluation of talent cultivation mainly focused on examination scores, competition results, employment rates (or further study rates), etc. Such a talent evaluation method is one-sided. Instead, a multi-dimensional talent evaluation mechanism combining short-term and long-term perspectives should be established from multiple aspects, including training bases, teachers, students, employers, and social services, integrating process-oriented assessment with result-oriented assessment.

To accurately determine whether the talents it cultivates meet the needs of enterprises and society, a university must establish a long-term and effective feedback and evaluation mechanism with students and employers. For students, long-term communication and surveys are required regarding their academic performance, further study or employment status upon graduation, internship and practical training experience, and job changes within 3 to 5 years after graduation. This ensures that the university’s talent cultivation can always be promptly aligned with enterprise needs.

Therefore, it is necessary to set up an evaluation team consisting of local governments, enterprises, professional teachers, students, and other stakeholders to jointly participate in the assessment. Based on students’ practical performance, academic performance, output achievements, and other multi-faceted and multi-angle indicators, the team will evaluate the achievements and shortcomings of universities in implementing industry-education integration and reforming talent cultivation models. This provides a reference basis for subsequent reform, innovation, and the revision and upgrading of programs, as shown in **Table 2**.

Table 2. Evaluation system for talent training in robotics automation

| Evaluation dimension | Short-term evaluation indicators | Long-term evaluation indicators | Evaluation subject | Evaluation tools/Methods | Feedback application |
|----------------------|---|--|---|---|---|
| Knowledge & Skills | Theoretical exam scores, 1+X certificate pass rate | Technical title promotion rate, patent/thesis output | School teachers, enterprise mentors | Examination system, certification platform | Adjust curriculum focus (e.g., strengthen industrial robot programming) |
| Practical Ability | Completion rate of practical training tasks, competition award level | Enterprise project contribution, key technical problem-solving ability | Training bases, cooperative enterprises (e.g., ABB) | Practical assessment form, project scoring system | Update practical training equipment (e.g., introduce new FANUC models) |
| Professionalism | Safety regulation compliance rate, team collaboration score | Workplace promotion speed, employer loyalty | Enterprise HR, internship mentors | Behavioral observation records, 360-degree assessment | Add career planning courses |
| Social Feedback | Internship unit satisfaction, social service participation rate | Graduate salary level, industry influence | Third-party institutions, alumni association | Questionnaire survey, big data analysis platform | Optimize school-enterprise cooperation direction (e.g., targeted training for shortage positions) |
| Comprehensive Growth | Semester comprehensive score (30% from enterprise + 40% from practical training + 30% from courses) | Career development trajectory within 5 years after graduation | Local government, school-enterprise joint committee | Digital growth file, follow-up interview | Revise industry-education integration policies |

4. Conclusion

This study focuses on the integration of industry and education in the Automation (Robotics) major at Hangzhou Dianzi University Information Engineering College (HDU-IEC) in the digital and intelligent era. Its core objectives are to address existing bottlenecks in the integration of industry and education in China, enhance the alignment between professional talent cultivation and industrial demands, and ultimately supply high-quality application-oriented talents to the industry. Against the backdrop of the continuous deepening of national policies on industry-education integration and the growing urgency of the industry's demand for digital and intelligent talents, the study accurately targets four core issues: vague definition of professional core competencies, unclear mechanism for promoting industry-education integration, lack of optimized talent cultivation programs, and difficulties in promoting practical experience. Through systematic research and practical exploration, a solution with both pertinence and operability has been developed.

During the research process, the team tracked cutting-edge industry technologies and surveyed job demands of leading enterprises, and constructed a pyramid-shaped system of professional core competencies covering knowledge, skills, and literacy, which clarifies the direction for talent cultivation. It further sorted out the existing industry-education integration models at HDU-IEC, identified obstacles in aspects such as resource input, cooperation depth, and communication mechanisms, and provided a basis for subsequent optimization. By means of theoretical analysis and empirical research, the team clarified the functional paths of curriculum, practice, and faculty development links on core competencies, and identified key influencing factors including

enterprise participation, the intensity of teaching reform, and policy support. On this basis, it optimized the curriculum system, deepened university-enterprise cooperation, and established a pilot evaluation mechanism, eventually forming a scientifically optimized talent cultivation program.

In terms of results, the study not only established the talent cultivation goal centered on “fostering virtue through education” and realized value guidance by constructing the “Six Fours” education chain, but also built an interdisciplinary curriculum system of “Automation Technology + Artificial Intelligence + Engineering Application” and a sound on-campus and off-campus practical training platform. Furthermore, it established a multi-dimensional evaluation mechanism co-conducted by universities and enterprises to achieve dynamic optimization of talent cultivation. These results have effectively improved the quality of talent cultivation in the Automation (Robotics) major at HDU-IEC, alleviated the shortage of talent in local industries, and the replicable practical models and operation guidelines have also provided important references for the development of industry-education integration in related majors of similar universities across the country.

In the future, the research will further dynamically adjust the system of professional core competencies and the talent cultivation program in accordance with the needs of industrial technology iteration and regional industrial upgrading, deepen university-enterprise collaboration in fields such as technological research and development and international production capacity cooperation, continuously improve the institutional mechanism for industry-education integration, and promote the integration of industry and education to develop in a deeper and higher-quality direction, thereby injecting stronger impetus into the digital and intelligent transformation of the automation (robotics) industry and the construction of a powerful education country.

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Strategy Design for the Quality Monitoring System of Mechanical Majors Based on Engineering Education Professional Certification

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Abstract: In response to the talent demands of engineering education professional certification for mechanical majors, this paper aims to cultivate applied and innovative talents and designs strategies for a teaching quality monitoring system. The strategies include the improvement of undergraduate talent training programs, the enhancement of theoretical classroom teaching quality, the improvement of practical course teaching quality, the enhancement of teachers' professional and teaching abilities, and the design of a diversified assessment system for course teaching quality. These five monitoring subsystem strategies cover the main areas involved in teaching work, ensuring continuous improvement in talent training programs, course construction, practical links, teachers' lecturing abilities, and teaching quality assessment. This system aims to continuously improve teaching quality and lay a foundation for the efforts to cultivate applied talents with solid theoretical knowledge, strong innovation capabilities, and practical skills.

Keywords: Mechanical engineering; Teaching monitoring system; Engineering education program; Continuous improvement; Assessment

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1. Introduction

The Washington Accord is an agreement for the mutual recognition of undergraduate engineering degrees. It was initiated and signed in 1989 by private engineering professional organizations from six countries: the United States, the United Kingdom, Canada, Ireland, Australia, and New Zealand. The agreement primarily addresses the mutual recognition of qualifications for undergraduate engineering degrees, which typically have a duration of four years. On June 2, 2016, China's application for full membership was unanimously approved by the Washington Accord General Assembly, becoming the 18th full member of the Washington Accord, thereby achieving international recognition for engineering education and engineering qualifications^[1-4].

Engineering education professional certification is a specialized accreditation implemented by professional

accreditation bodies for engineering programs offered by universities. It is conducted by professional associations (federations), professional societies, along with educational experts and industry experts in the field, to provide a guarantee of quality for preparatory education for engineering and technical personnel entering the industrial sector. It is also an internationally recognized system for ensuring the quality of engineering education and serves as an important foundation for the international recognition of engineering education and engineering qualifications. The core of this certification is to confirm that engineering graduates meet the established quality standards recognized by the industry, and it is a qualification evaluation oriented towards educational goals and graduation requirements ^[5].

The implementation of engineering education professional certification in China is beneficial for constructing a quality monitoring system for engineering education, advancing engineering education reform, and further improving the quality of engineering education. It establishes a professional certification system for engineering education that is connected with the engineer system, promotes the connection between engineering education and the industry, enhances the adaptability of engineering education talent training to industrial development, and facilitates the international recognition of Chinese engineering education, thereby enhancing the international competitiveness of China's engineering and technical talents. Therefore, only schools (and majors) that have undergone engineering education professional certification can gain greater social recognition, and their graduates will be more readily accepted ^[6].

2. The current state of teaching for mechanical engineering majors under engineering education professional certification

Since the 1990s, research on ensuring the quality of higher education has emerged worldwide, with more than 100 countries establishing higher education quality assurance agencies. Currently, there are four main models for higher education quality assurance and evaluation internationally: the institutional audit model represented by the United Kingdom, the quality accreditation model represented by the United States, the self-assessment model represented by Japan, and the government assessment model represented by France ^[7].

China's general undergraduate teaching quality assurance system is in the stage of research and development. Ma ^[8] has constructed a quality monitoring and evaluation system for the practical teaching of mechatronics majors, but it is not closely integrated with engineering practice and lacks sufficient training in engineering thinking. Both Cao ^[9] and Pan ^[10] have proposed reform suggestions from the perspective of professional course teaching quality evaluation, but they have overlooked the process supervision of both theoretical and practical teaching. Huang ^[11] has provided methods for the continuous improvement of theoretical teaching quality from aspects such as training programs, curriculum systems, classroom teaching quality, and course design, but the teaching of practical courses has seen little effect. Mei Yi, based on the philosophy of engineering education professional certification, conducted a teaching quality analysis of manufacturing equipment courses. By integrating innovative awareness and engineering application capabilities, it has, to some extent, improved the ability to solve simple engineering problems, but there is a lack of teaching feedback information ^[12].

Analyzing the current state of research, the deficiencies in the teaching status of mechanical engineering majors are mainly manifested as: insufficient investment in practical teaching equipment, a lack of applied teaching staff, incomplete monitoring systems for theoretical and practical teaching processes, a lack of detailed teaching feedback loops, and an imperfect assessment mechanism.

3. Constructing a teaching quality monitoring system for mechanical engineering majors in the context of engineering education certification

Engineering education professional certification adheres to the principle of student-centeredness, with a focus on student learning outcomes (Outcome-based), and evaluates the achievement of course teaching objectives and the teaching process as two key points. It also features a continuous and effective quality improvement mechanism, which is an important criterion for assessing the quality of undergraduate teaching^[13]. Jiangsu Ocean University's School of Mechanical Engineering offers majors in Mechatronics Engineering, Mechanical Design, Manufacturing and Automation, and Robotics Engineering, with both Mechatronics Engineering and Mechanical Design, Manufacturing and Automation having successfully passed the engineering education professional certification. The teaching quality monitoring system is an important measure to ensure the quality of undergraduate education; its scientific integrity directly affects the enhancement of teaching quality. An unscientific monitoring system not only fails to guarantee the quality of talent cultivation but may also have a negative impact on the normal development of students^[14]. Therefore, it is necessary to design a teaching quality monitoring system strategy for mechanical majors based on engineering education professional certification. On one hand, by conducting an in-depth analysis of the current teaching quality monitoring, the system can be improved, facilitating the review of mechanical majors that have passed the engineering education professional certification. On the other hand, it is beneficial for the Robotics Engineering major to apply for and pass the engineering education professional certification. This teaching quality monitoring system includes the strategic design of the following five monitoring subsystems, as shown in **Figure 1**.

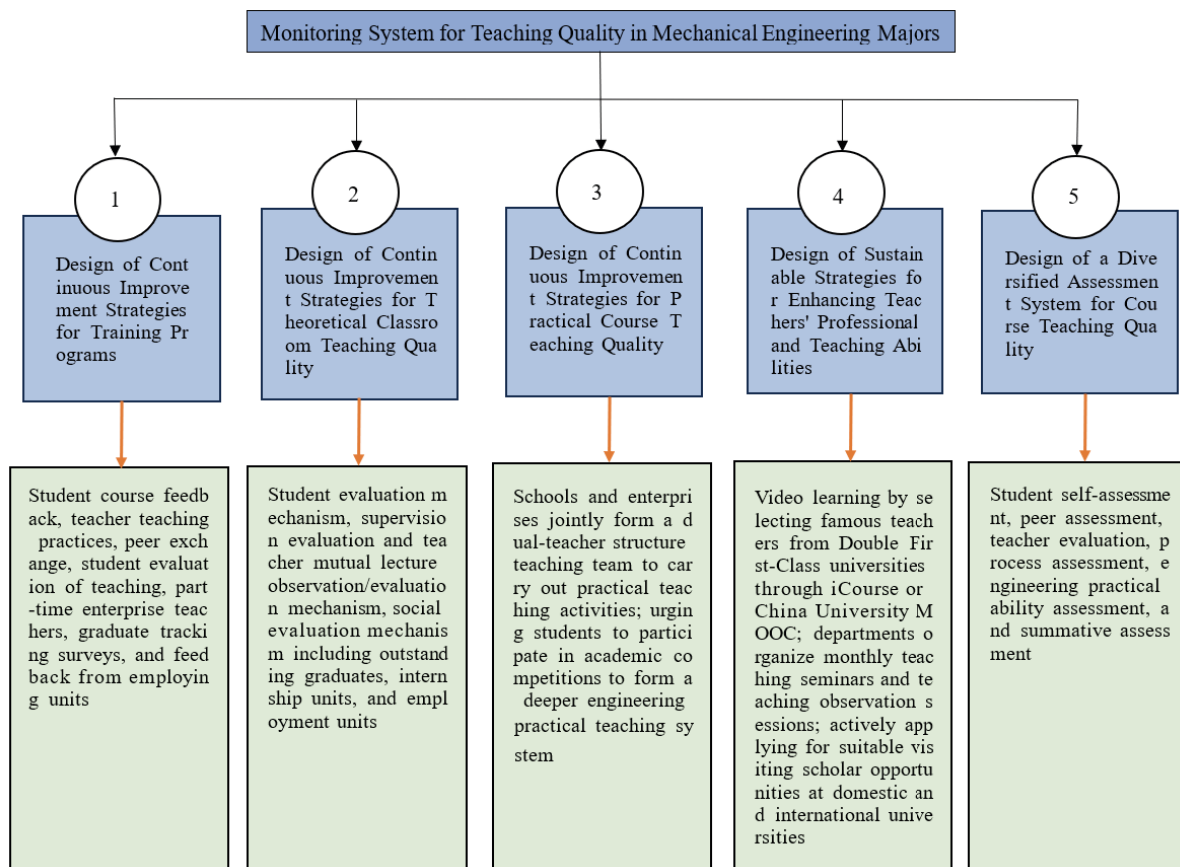


Figure 1. Teaching quality monitoring system for mechanical engineering programs.

3.1. Continuous improvement strategy design for undergraduate talent training programs based on the strategic goal of ‘Building a well-known, distinctive high-level applied research-oriented maritime university in China’

Based on the OBE (Outcomes-Based Education) teaching philosophy, the training objectives for mechanical engineering majors should be supported by appropriate teaching content, and the knowledge and ability requirements in the courses must fully cover the professional ability requirements in the course objectives. The formulation and revision of the talent training plan stem from student course feedback, teaching practices of faculty, peer exchanges, student evaluations of teaching, part-time teachers from enterprises, tracking surveys of graduates, and feedback from employers. The continuous improvement design of the talent training plan is a core element of engineering education. There should be a minor adjustment to the talent training plan every year and a fine-tuning every four years, guided specifically by the achievement of course objectives. Teaching content should also keep pace with societal and industry development needs. The selection of teaching methods should serve the realization of course objectives, and the course syllabus must have a clear correspondence with the graduation requirements indicators and support the requirements in the professional ability matrix. It should be explicit in the syllabus which abilities are being supported and cultivated. The course syllabus should act as a “guide” for the course teaching process. The development of the course syllabus is a key component of course evaluation, and course evaluation is the closed-loop feedback tracking mechanism of the teaching quality monitoring system.

The method of course evaluation is based on the course syllabus, employing the rationality evaluation and achievement evaluation of course objectives. The rationality evaluation of courses is conducted on an annual basis, throughout the entire semester in which the course is offered, ending at the end of the term. The evaluation sample consists of the current students. Based on the evaluation results, the relevant course team proposes continuous improvement measures. The course evaluation results are kept together with the exam papers in the exam paper box. Achievement evaluation includes assessments of the achievement of professional training objectives, graduation requirements, and course objectives. Professional training objectives are supported by the achievement of graduation requirements, which in turn are supported by the achievement of course objectives. Whether graduates can match the needs of society and industry development, align with the school’s educational positioning, and correspond with the characteristics of the major largely depends on the formulation of professional training objectives. Graduation requirements are established based on the capability elements of the training objectives. The ability to formulate effective continuous improvement measures and enhance the quality of talent cultivation and the development of the entire major depends on the objectivity, scientific nature, and comprehensiveness of the evaluation system.

Jiangsu Ocean University’s School of Mechanical Engineering, to ensure the stability and continuity of teaching, will keep the “2 stages + 4 platforms + 10 modules” curriculum system essentially unchanged in the 2024 revision of the training plan. At the same time, based on the continuous improvement strategy of the talent training plan and the university’s own characteristics as well as the needs of the maritime field, a curriculum system that unifies normativity and autonomy in talent training is constructed. The setting of training objectives and graduation requirements follows the national standards for teaching quality. The adjustments to the 2024 training plan are as follows: To highlight the maritime characteristics of the curriculum system, at least 3 maritime characteristic professional courses are set (including 1 compulsory professional course), and the compilation of textbooks that meet the needs of the maritime field and the characteristics of the school is

encouraged. Practice with maritime characteristics is carried out to cultivate students' awareness of knowing the sea, loving the sea, protecting the sea, and strengthening the sea. To strengthen the collaborative training of industry and education, the proportion of industry-education integrated courses has increased to more than 30%. To enhance the effectiveness of practical teaching, the proportion of practical credits is increased to more than 35%, and students are encouraged to concentrate on internships and training in enterprises in their fourth year. To promote the alignment of course design with international standards, at least 2 bilingual or fully English international courses are offered. Students are encouraged to use appropriate digital tools, platforms, and resources through digital platforms to enhance their digital learning capabilities, and to cultivate and stimulate students' digital learning power, adaptability, and creativity.

3.2. The design of continuous improvement strategies for theoretical classroom teaching quality based on feedback information

The theoretical classroom teaching adheres to a student-centered approach, with a focus on student learning outcomes as the guiding principle. It encourages student participation in the teaching process by integrating engineering scenarios with theoretical classroom instruction, thereby stimulating the students' internal motivation to learn. Teachers shift from being the "leaders" of teaching to facilitators, ensuring that the teaching process is centered on student development. This approach enhances students' interest in their professional studies, which is conducive to creating a cognitive environment that allows students to more deeply understand engineering theories and principles. To improve the quality of theoretical classroom teaching, establishing a continuous improvement strategy for classroom teaching quality based on feedback information is essential.

Firstly, establishing a reasonable student teaching evaluation mechanism is essential. This mechanism includes mid-term and final-term teaching evaluations. As the primary evaluators, students assess the teaching quality of teachers through attending classes, questionnaires, and discussions, providing suggestions for improvement to enhance the teaching skills of the teachers. The mid-term teaching evaluation scores constitute 20% of the total student evaluation scores. As the primary evaluators once again, students assess the teaching quality of teachers through the same methods for the final-term teaching evaluation, which constitutes 80% of the total student evaluation scores. These student evaluation scores are then integrated into the teacher's title evaluation process.

Subsequently, establish a supervisory teaching evaluation and peer listening to lectures and evaluate the teaching mechanism. The school and college form a supervision team to systematically oversee teachers' lesson plans, preparation, teaching performance, classroom attendance, teaching logs, and schedule adjustments or cancellations through random checks, discussions, student interviews, and questionnaire surveys. The college mandates that each teacher attend one class of six different teachers per semester. Through peer listening to lectures and evaluating the teaching mechanism, mutual teaching and learning are facilitated.

Finally, establish a social evaluation mechanism that includes outstanding graduates, internship units, and employment units. Through mechanisms such as outstanding graduate discussions and visits to internship and employment units, provide external support for the continuous improvement of course teaching and talent training programs through external tracking and feedback.

Reflect the teaching and talent cultivation issues identified by the aforementioned evaluation mechanism in a timely manner to the relevant teaching responsibility units or directly responsible individuals. Verify, process, and respond to the feedback, and make improvements in subsequent classroom teaching. Additionally, the

improvement process and its effects must be tracked and documented.

3.3. Design for the continuous improvement of teaching quality in practice-based courses focused on engineering practice and innovative capabilities

Building on the theoretical professional studies of the first two academic years, the third year begins with the engineering practice teaching segment, placing a strong emphasis on cultivating students' engineering concepts and the ability to solve complex engineering problems. By integrating classroom teaching with experimental practice and industrial site projects through the engineering practice segment, the focus is on developing students' practical engineering and engineering application skills.

Practical teaching also adheres to a 'student-centered' approach, and the engineering practice capabilities of teachers directly affect the quality of talent cultivation in this specialty. Therefore, it is particularly important to have a high-level, practical teaching team. Consequently, schools and enterprises jointly form a dual-teacher structured teaching team to carry out practical teaching activities, allowing team teachers to move freely between schools and enterprises. Among them, in-school instructors are required to regularly visit research institutes and enterprises for further study, conduct research topics, and participate in joint development projects (for no less than two months) each year to continuously improve their theoretical knowledge and practical skills. Enterprise instructors are mainly senior engineers with more than five years of work experience. Half of the class hours for each core practical course are taught personally by enterprise instructors, with content closely related to production practice, and in-school instructors follow up throughout. On one hand, students gain a deeper understanding of the theoretical part through the study of actual enterprise cases, effectively enhancing their engineering design capabilities, engineering innovation capabilities, and hands-on skills. On the other hand, in-school instructors can better connect theory with practice. Additionally, enterprise instructors assess students' engineering practice abilities and determine whether their practical skills meet the production requirements of enterprises. At the same time, enterprise monitoring and evaluation mechanisms are introduced to dynamically supervise and provide feedback on various teaching segments of engineering practice, and continuous improvements are made based on the feedback to enhance the teaching effectiveness of engineering practice courses and achieve the goal of cultivating high-level applied research talents.

Disciplinary competitions serve as a platform to demonstrate students' comprehensive qualities and their ability to solve practical problems. They are one of the ways to assess students' learning outcomes. By organizing mechanical discipline competitions and innovation contests, while also focusing on the integration of multidisciplinary knowledge and the cultivation of professional skills, a deeper engineering practice teaching system can be formed. This allows students to develop excellent professional engineering literacy and innovation capabilities during their time at school. Additionally, students should actively apply for national, provincial, and university-level college student innovation and entrepreneurship projects, widely participate in teacher-led research topics, and engage in innovation and entrepreneurship activities to further hone their learning skills, engineering practice skills, and innovative design capabilities.

3.4. Designing sustainable strategies for the enhancement of teachers' professional and teaching abilities

The college encourages each teacher to select top-tier university teaching from the 'Love Courses' or 'China University MOOC' platforms that offer courses identical to their own, for video-based learning. The learning

content includes teaching methods, course key points and difficulties, course schedule arrangements, interaction methods with students, homework assignments, assessment methods, etc. If there are any questions or ideas, teachers should actively engage in discussions with the instructors to continuously improve their professional capabilities.

The department organizes a monthly teaching seminar and teaching observation study, requiring young teachers to actively participate, thereby better facilitating resource sharing, learning from others' strengths, and continuously improving their own teaching levels. At the same time, young teachers are organized to participate in basic teaching skills competitions, innovative teaching contests, national and provincial teaching competitions, and young doctoral teachers are sent to enterprises for temporary positions to enhance their teaching abilities.

The school has a quota for visiting scholars each year. Teachers who teach courses and conduct research should actively reach out to well-known universities at home and abroad, and select the most suitable institutions to apply for visiting study. During their visit, they should actively engage in teaching exchanges with the host department, participate frequently in lesson observation and evaluation activities, and attend academic events to broaden their research fields, thereby improving their teaching and research capabilities as much as possible.

3.5. Design of a diversified assessment system for course teaching quality

In traditional teaching models, teachers are the main body in assessing students' academic performance, and students can only passively accept the teacher's evaluation, which does not fully reflect the students' achievements. American psychologist Bandura's triadic reciprocity theory suggests that cognition of external objects should combine three elements: environment, behavior, and person. This theory provides a basis for reforming assessment methods. Guided by the philosophy of engineering education professional accreditation, the evaluation has expanded from traditional teacher assessment of students to include self-assessment by students, peer assessment, teacher evaluation, process-based assessment, engineering practice ability assessment, and summative assessment. The evaluation subjects have shifted from a monolithic to a diversified approach.

The design of a diversified assessment system for course-teaching quality includes: self-directed learning (5%), independent homework completion by students (5%), classroom discussions (10%), transitional assessment (20%), engineering practice capability assessment (30%), and final-exam score (30%). The specific distribution is shown in Figure 2. Specifically, reviewing the main content of the previous class through questions at the beginning of the class to understand students' independent study is part of the self-assessment by students. To ensure students better grasp key and difficult knowledge, teachers need to assign targeted homework, and the students' timely and independent completion of this homework falls under the peer-assessment category. In the teaching process, classroom discussions and questions are used to gauge students' enthusiasm for the course and their learning status, which is part of the teacher's evaluation. Attendance and mid-term assessments are used to understand the teaching situation and students' mastery of knowledge, to identify issues in a timely manner and make corrections, which is part of the process assessment. Engineering practice ability is assessed by enterprise instructors who set project topics based on enterprise production needs, to evaluate students' practical skills and determine whether their operational skills meet the production requirements of enterprises. The final exam scores represent the culmination of the assessment process.

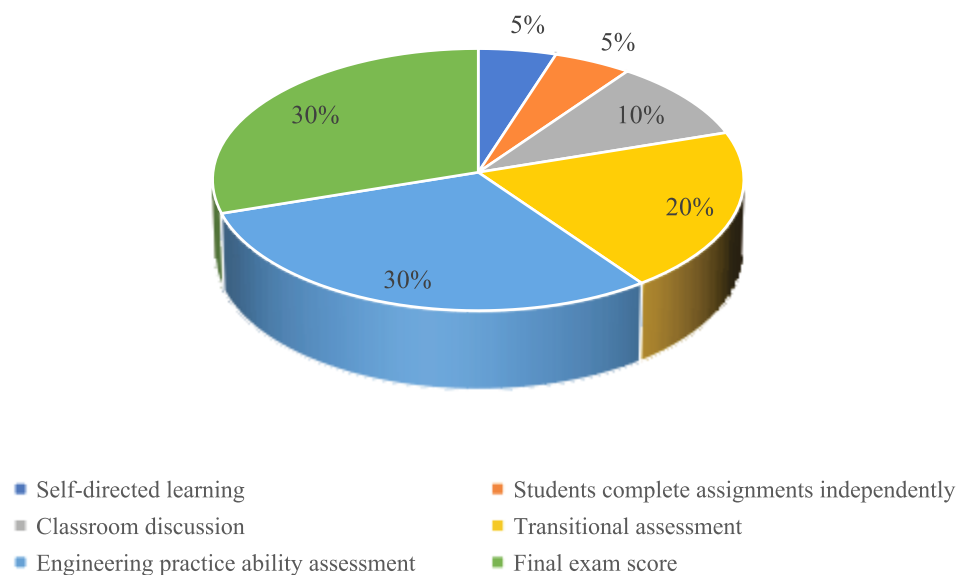


Figure 2. Distribution of the diversified assessment system for course teaching quality.

By employing this diversified assessment system, the primary responsibility for learning is emphasized among students, and their learning progress is monitored throughout the entire teaching process. This approach fosters students' interest in their academic field and enables the timely identification of issues within the teaching process, leading to continuous improvements and an enhancement in the quality of talent development.

4. Conclusion

The teaching quality monitoring system strategy proposed in this paper leverages the opportunity of engineering education professional accreditation to further refine the undergraduate talent training plan, enhance the quality of theoretical classroom teaching, improve the teaching quality of practical courses, elevate the professional and teaching capabilities of faculty, and design a diversified assessment system for course teaching quality. The strategic design of these five monitoring subsystems encompasses the main areas involved in teaching work, ensuring the continuous improvement of talent training plans, course development, practical components, faculty teaching abilities, and teaching quality assessments. This system is designed to continuously enhance teaching quality and achieve a progressive enhancement in the cultivation quality of high-level applied research talents.

Disclosure statement

The authors declare no conflict of interest.

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Reflections on the Phenomenon of Work Slackening Among Award-Winning University Student Cadres and Countermeasure Research

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Abstract: Student cadres serve as a crucial force in university campus governance, cultural development, and the cultivation of academic ethos. They play key roles in campus administration, academic atmosphere construction, and university-industry collaboration practices. The initial purpose of merit-based recognition and incentive systems is to encourage student cadres to assume responsibilities and exemplify leadership. However, a phenomenon has been observed where some student cadres at this institution exhibit a decline in performance after receiving university or college-level “Outstanding Student Cadre” honors, manifesting as negative work attitudes, reduced efficiency, and diminished team collaboration effectiveness. This not only hinders the cadres’ own development of applied competencies but also impacts the execution of various university tasks. Grounded in the practical context of student cadre work at Huaiyin Institute of Technology, this paper analyzes the significance of enhancing student cadre work enthusiasm from three perspectives: “personal growth,” “campus development,” and “talent cultivation.” Subsequently, addressing the characteristics of engineering students and shortcomings in existing management mechanisms, it proposes pathways—from the “individual,” “institutional,” and “environmental” dimensions—to strengthen value orientation, sustain motivation, and foster a supportive atmosphere, thereby promoting continuous advancement among student cadres and improving the overall effectiveness of student affairs at the institution.

Keywords: Student cadres; Incentive mechanisms; Campus management; Academic atmosphere construction; Cultivation of applied talents

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1. Introduction

The report of the 20th National Congress of the Communist Party of China strategically emphasizes that “training a large number of high-quality personnel with both moral integrity and professional competence is a major issue of long-term importance for the country and the nation,” charting the course for talent cultivation in higher education^[1]. Similarly, the “Guiding Opinions on Accelerating the Construction of ‘Double First-Class’

in Higher Education Institutions” jointly issued by the Ministry of Education and other departments underscores the practical requirement to “advance curriculum reform, strengthen the integrated design of curricula and teaching across different training stages, and adhere to teaching students in accordance with their aptitude”^[2]. Within university student management and affairs, student cadres function as a mainstay force^[3]. They act as bridges for communication between staff and students and leaders in student self-governance and academic ethos enhancement, assisting the university in conducting student work and fostering a positive learning environment and campus culture. Universities typically employ various merit-based recognition methods to incentivize active participation, granting student cadres honors and awards to promote performance through evaluation. However, a recent phenomenon noted in some literature is the tendency for student cadres to “slack off after receiving awards”^[4], which is detrimental to both the cadres’ own development and team building, hinders the smooth operation of university functions, and has become a pressing issue requiring resolution.

2. The significance of student cadre work enthusiasm in universities

Student cadres play a vital role in university student management.

(1) For personal growth

Enhancing Employability through Integration with Engineering Background. Many student cadres at this institution hail from engineering majors such as Mechanical Engineering, Electronics, and Computer Science. Their work responsibilities often intersect with practical applications of their disciplines. Highly motivated cadres can effectively integrate student work with professional skill development. For instance, organizing activities like “Engineering Training Competitions” or “Electronic Design Competitions” hones teamwork and resource coordination abilities, thereby deepening the application of specialized knowledge.

(2) For campus development

Ensuring Efficient Implementation of Engineering-Oriented Tasks. Student cadres serve as crucial links in engineering-focused tasks such as “Engineering Training Center Management,” “Internship Leadership,” and “Laboratory Coordination.” Their work enthusiasm directly influences execution outcomes.

(3) For talent cultivation

Fulfilling the Educational Goal of Integrating Moral and Technical Prowess. Student cadre work is a significant avenue for blending “moral education” with “technical education”. Enthusiastic cadres proactively fulfill responsibilities. For example, in “Engineering Students Serving the Community” volunteer initiatives, they research needs and organize support activities, applying professional skills while disseminating a spirit of collaboration. Conversely, work indolence undermines the educational function of these platforms.

3. Manifestations of work slackening among award-winning student cadres

Some university student cadres exhibit various signs of work slackening after receiving awards, primarily concentrated in three areas: negative work attitudes, decreased work efficiency, and poorer team collaboration^[5].

(1) Negative work attitudes

Prior to receiving awards, student cadres at Huaiyin Institute of Technology and other universities

often demonstrate proactiveness in participating in campus activities, assisting faculty with class management, and serving fellow students, displaying a sense of ownership and responsibility. However, after being honored, some cadres exhibit a “relaxation of effort,” showing diminished drive towards tasks and faculty assignments, even displaying behaviors like procrastination and perfunctory completion. They may become particularly averse to routine administrative tasks, easily losing sight of the original intent of organizational commitment and service.

(2) Decreased work efficiency

The decline in proactive attitude directly impairs the work efficacy of student cadres. Procrastination becomes more prevalent, affecting overall work progress. When arranging tasks, they may merely follow procedures mechanically without seeking ways to improve efficiency or quality. Organizing campus events often relies on “tried-and-true” methods without adaptation to actual circumstances or needs, leading to rigid, inflexible activities with low participation rates. Faced with difficulties or problems, they tend to avoid them or shift blame rather than actively seeking solutions, allowing issues to persist or worsen.

(3) Deteriorating team collaboration

University student cadre work primarily involves collective effort. After receiving awards, some cadres exhibit reduced willingness and efficiency in cooperation. During group discussions, they are reluctant to voice their opinions and may disdain or disrespect others’ views, displaying pronounced individualism and capriciousness. In practice, they neglect communication and collaboration, failing to share workloads or potential issues with team members, resulting in low overall team synergy. Some cadres hold strong notions of personal interest and weak team spirit, basing decisions and actions primarily on individual benefit, sometimes even pursuing honors at the expense of other cadres’ interests, leading to competition and conflict within the team and an overall discordant organizational atmosphere.

4. Analysis of causes for work slackening among award-winning student cadres

The phenomenon of work slackening among university student cadres after receiving honors such as university/college-level “Outstanding Student Cadre” titles not only affects their personal growth and capability enhancement but also weakens the overall operational efficiency of student organizations and the healthy functioning of campus governance^[6]. This issue is not accidental but stems from a combination of factors at the individual, institutional, and environmental levels.

4.1. Individual factors

(1) Post-goal attainment lethargy

For some student cadres, merit-based recognition represents a significant, motivating objective in their student work. To achieve this goal, they invest considerable time and effort in striving for faculty satisfaction and peer recognition. However, once the goal is attained, a lack of subsequent targets leads to relaxation, resulting in diminished motivation and passion for work. They may cease efforts to improve their capabilities and efficiency, resorting to perfunctory completion and superficial efforts.

(2) Distorted self-perception

After receiving honors, some student cadres develop a skewed understanding of their responsibilities and mission. They may treat the honor as an identity label rather than an impetus for continuous improvement as a cadre, or even as an “exemplary representative,” feeling exempt from the need for sustained contribution and dedication to other students. An inflated self-assessment and overemphasis on past achievements can stifle the drive for further learning and progress.

(3) Failure to balance academics and work

Many student cadres must juggle student responsibilities with academic performance. Some may prioritize work for award consideration, often working late nights or even neglecting studies. After receiving awards, some cadres, due to poor academic performance or heightened self-perception, may relax their self-discipline. Unsatisfactory academic results can dampen work enthusiasm. Furthermore, since merit-based evaluations are often linked to academic grades, poor performance can preclude future honors, leading to frustration and disappointment, which in turn reduces proactive engagement in work. Additionally, some cadres lack effective time management and planning skills, struggling to accurately allocate time between work and studies, often leading to an imbalance. Prolonged conflict and divided attention can result in unsatisfactory outcomes in both areas.

4.2. Institutional factors

(1) Inadequate incentive and assessment mechanisms

Current incentive mechanisms for student cadres exhibit certain shortcomings. For instance, they are often uniform in form and lack long-term sustainability. Recognition primarily consists of honorary certificates and limited material rewards, which, while motivating in the short term, can lead to “reward fatigue” among cadres, gradually diminishing motivation. This is particularly true for previously awarded cadres; without subsequent recognition, issues like lack of initiative and confidence can easily arise. Concurrently, evaluation systems are often incomplete. On one hand, assessment rules may be unclear, lacking standardized frameworks and scientific indicator systems. On the other hand, evaluation processes might be irregular, overly influenced by peer relationships, compromising fairness and impartiality. Finally, the widespread lack of supervision and inspection mechanisms for potential misconduct in student work weakens the constraining force of these systems, enabling some cadres to perform their duties perfunctorily.

(2) Lack of post-award cultivation and support

After receiving honors, there is generally a systemic lack of follow-up cultivation and supportive measures for student cadres. Most higher education institutions have not established specialized development plans or training programs for cadres. Post-award, their competency structures and performance are not systematically adjusted or enhanced. The absence of procedural guidance and resource support means cadres facing difficulties or problems in practical work lack timely advice. Some faculty advisors may not provide sufficiently immediate feedback or guidance, leaving cadres feeling lost or at a loss, which affects their motivation. Furthermore, the lack of collaborative channels and information exchange platforms between departments deprives cadres of adequate support in cross-departmental and comprehensive tasks. The absence of inter-organizational cooperation invisibly increases work difficulty and pressure, weakening the cultivation of cadres’ comprehensive abilities.

4.3. Environmental factors

(1) Shifting attitudes of peers

After recognition, the attitudes of surrounding peers can change, impacting the cadres' psychological state and work performance. On one hand, praise and admiration from some students can foster arrogance in cadres, leading them to believe they have already gained sufficient recognition and lack motivation for further development. Interactions with peers might reveal a sense of superiority, causing them to overlook others' opinions, undermining their grassroots support base, and affecting their practical work effectiveness. On the other hand, jealousy might lead to passive-aggressive behavior from peers. This can create additional psychological pressure for cadres, even fostering resistance towards student work. When performing duties, non-cooperation from certain peers or unreasonable demands can increase operational difficulties, reducing the cadres' own work enthusiasm and initiative, resulting in negative attitudes and impacted performance.

(2) Campus management culture and atmosphere

A results-oriented campus culture that undervalues process, collaboration, and fosters excessive competition can negatively influence the values and attitudes of student cadres. In an environment where the pursuit of honors is paramount, cadres may undervalue personal capability enhancement, procedural experience, and collaborative work. Some might even engage in inappropriate behavior or excessively self-promote while disregarding other team members to win accolades, hindering the establishment of harmonious organizational relationships and a positive team atmosphere. Moreover, if the university's focus on organizing and judging campus activities lies solely on final outcomes and honors gained, without substantive recognition or evaluation of the implementation process, student participation, and particularly the efforts of student cadres, it may lead cadres to feel their efforts are unappreciated, discouraging further contribution. More seriously, such a utilitarian cultural atmosphere can exacerbate utilitarian thinking, causing individuals to focus excessively on personal interests and honors at the expense of peers and the original purpose of self-development, which is detrimental to healthy student growth.

5. Countermeasures to overcome work slackening among award-winning student cadres

5.1. Individual level

(1) Foster correct values and professional outlook

Universities can regularly conduct education on values and professional ethics for student cadres. Inviting relevant experts, scholars, outstanding cadres, and corporate leaders to share experiences can illustrate the benefits of holding correct values, helping cadres understand that personal value is realized through serving others, not the other way around. Additionally, establishing themed dialogue sessions on value construction can encourage discussion, promoting cadres' recognition, internalization, and practice of sound value beliefs.

(2) Develop long-term goals and plans

Universities can assign advisory faculty to help student cadres formulate personalized long-term and short-term development goals based on their strengths, interests, and career aspirations, breaking these down into actionable steps. Advisors can require cadres to set staged objectives and deadlines. Cadres

should also conduct regular self-assessments and make adjustments. Organizing experience-sharing sessions on goal management, where successful cadres share strategies, can provide insights and methods for others, enhancing the team's awareness and initiative in goal management.

(3) Learn time management and task delegation

Universities can offer training courses on time management and task allocation, covering theories and practical methods like the Pomodoro Technique or Eisenhower Matrix. Guiding cadres to use calendars, task management software, etc., for recording, categorizing, and prioritizing academic and work tasks can help them allocate time effectively and manage workloads according to urgency and importance.

5.2. Institutional level

(1) Establish diversified incentive mechanisms

Universities should construct multi-dimensional incentive systems encompassing material, spiritual, and opportunity-based rewards, providing a conducive development environment for student cadres.

(A) Material incentives: Beyond standard honorary certificates and monetary rewards, offer more targeted, differentiated, and practical rewards based on actual performance for more direct and noticeable motivational impact.

(B) Spiritual incentives: Utilize commendations and publicity of deeds to enhance cadres' sense of achievement and belonging. Feature columns like "Outstanding Student Cadre Profiles" on university websites, newspapers, and WeChat platforms can showcase their accomplishments, leveraging their role as "locomotives" for inspiration.

(C) Opportunity incentives: Provide more opportunities for cadres to exercise skills, innovate, and showcase abilities. Recommend outstanding cadres for high-level student leadership training or corporate internships, allowing them to demonstrate talent on broader platforms and lay a solid foundation for future careers.

(2) Improve assessment and supervision systems

Develop scientific and standardized evaluation criteria for student cadres. Standardize assessment standards and procedures, scientifically designing quantifiable indicators for work attitude, capability, performance, and teamwork. Establish a scientific evaluation system combining regular reviews and routine assessments, incorporating methods like student democratic evaluation, faculty advisor assessment, cadre self-reflection reports, and peer reviews to comprehensively and fairly reflect actual work performance.

5.3. Environmental level

(1) Strengthen campus culture construction

Organize cultural weeks, science and technology festivals, sports events, and other activities to foster a positive and uplifting campus culture, cultivating a spirit of unity, collaboration, and dedication among cadres. Enhance the promotion and guidance of campus culture through media like campus radio, bulletin boards, and websites to reinforce cadres' team consciousness and commitment to service.

(2) Implement peer education and mutual aid

Regularly hold exchange meetings or seminars for cadres to share experiences, summarize lessons, and learn from each other. Address common work issues through forum discussions to analyze causes,

find solutions, and establish cooperative support networks. Furthermore, create structured peer support groups for student cadres based on majors, strengths, or work areas, facilitating regular internal communication and mutual assistance. This peer education and support model enhances cohesion and solidarity within the cadre team, promoting collective improvement.

(3) Optimize faculty-student communication and feedback mechanisms

Create favorable conditions for communication between student cadres and faculty. Cadres should proactively communicate with advisors, reporting on work, raising issues, seeking help, and accepting guidance. Faculty, in turn, should initiate communication with cadres, understanding their work and personal circumstances, showing concern for academic and life challenges, and providing guidance and support. Simultaneously, establish robust feedback mechanisms allowing cadres to promptly receive evaluations and suggestions from faculty and peers, enabling targeted improvements in work methods and behavior. Implementing reward mechanisms for constructive communication and continuous improvement based on feedback can stimulate intrinsic motivation for self-refinement and enhance overall competence.

6. Conclusion

In summary, this paper identifies the phenomenon of work slackening among university student cadres post-award, outlining issues related to attitude, efficiency, teamwork, and impacts on the individual, organization, and campus. Analysis from the individual, institutional, and environmental perspectives reveals contributing factors. Corresponding countermeasures are proposed: individuals need to establish correct values, set ambitious goals, and enhance time management awareness; institutionally, it is essential to improve incentives, assessment, supervision, and long-term cultivation systems; environmentally, efforts should focus on refining the campus and peer milieu, along with faculty-student communication mechanisms, to foster the development of university student cadres.

Disclosure statement

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Exploration of Blended Teaching Model for “Circuit Theory” Course Under the Background of “Internet +”

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Abstract: Under the background of “Internet +”, higher education teaching has ushered in new opportunities for reform. How to more effectively cultivate students’ professional literacy and comprehensive abilities has become a teaching problem troubling college teachers. In this regard, this paper takes Changjiang Rain Classroom as the technical support, conducts an in-depth study on the application path of the blended teaching model in the teaching of “Circuit Theory” course, aiming to provide valuable references for improving teaching effects and promoting teaching reform.

Keywords: “Internet +”; Circuit Theory; Blended teaching

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1. Introduction

Under the background of “Internet +”, the informatization of higher education has become a trend of educational reform^[1]. As one of the core courses for Electrical Engineering and Automation majors, the teaching of “Circuit Theory” not only undertakes the important task of imparting basic theoretical knowledge and skills to students but also shoulders the important mission of cultivating students’ practical ability, innovative ability, and engineering thinking. However, the traditional teaching model has many shortcomings, such as being limited by teaching time and space, weak interactivity, and insufficient teaching resources, which make it difficult to meet students’ diverse learning needs and affect the improvement of teaching effects of “Circuit Theory”^[2]. Blended teaching is an innovative teaching model. By combining online and offline teaching, it can not only effectively stimulate students’ learning interest and mobilize their enthusiasm and initiative, but also break the limitations of teaching time and space, and more effectively improve teaching effects. Applying it to the teaching of “Circuit Theory” can effectively make up for the limitations of traditional teaching, improve teaching effects, and provide students with a platform for independent learning and collaboration, laying a solid foundation for improving learning effects.

2. Significance of applying the blended teaching model in the “Circuit Theory” course

2.1. Break the limitations of teaching time and space

In previous course teaching, teaching time and space were relatively fixed, and students needed to participate in teaching activities at fixed locations within the required time^[3]. This teaching model is relatively rigid and lacks flexibility, making it difficult to meet the diverse needs of contemporary college students. By applying the blended teaching model, with the help of the intelligent tool Changjiang Rain Classroom, students can break the limitations of teaching time and space according to their own needs, and obtain high-quality teaching resources such as teaching videos, preview materials, and microcourses anytime and anywhere, thereby effectively improving learning efficiency.

2.20 Promote the combination of theory and practice

“Circuit Theory” is a discipline with a strong theoretical and practical nature. It requires students to not only master solid theoretical knowledge but also have strong practical ability^[4]. However, in previous course teaching, there was a lack of close integration between theory and practice. Students found it difficult to apply the learned theoretical knowledge to specific practices, which seriously hindered the improvement of their practical and problem-solving abilities. Under the blended teaching model, virtual reality, augmented reality, and other technologies can be introduced to build virtual simulation laboratories. Students can conduct practical training operations in virtual and realistic scenarios, polish their skills, understand theoretical knowledge more deeply, and gradually improve their practical and problem-solving abilities.

2.3. Meet students’ diverse needs

In previous course teaching, students’ individual differences were often ignored by teachers. Teachers often adopted a “one-size-fits-all” teaching model, which was difficult to meet the diverse needs of different students^[5]. Under the blended teaching model, teachers can use Changjiang Rain Classroom to collect and analyze students’ learning behavior data, such as homework completion, classroom interaction frequency, and classroom test accuracy, and generate objective and personalized learning reports. Based on this, teachers can adjust teaching strategies and optimize teaching content in a timely manner, thereby effectively improving the pertinence of course teaching, better meeting the diverse needs of students at different levels, and laying a foundation for their comprehensive development in the future.

3. Problems existing in the previous teaching of the “Circuit Theory” course

There are many problems in the previous teaching of the “Circuit Theory” course, such as insufficient classroom participation, disconnection between theory and practice, and a single evaluation method, which seriously affect the improvement of teaching effects^[6]. In this regard, this paper conducts an in-depth analysis of the following aspects.

3.1. Insufficient classroom participation

In previous course teaching, teachers often occupied a dominant position, and the teaching method was mainly “explanation + practice.” Students were often in a passive acceptance state, and the form of interaction was mainly classroom questioning, which was relatively single^[7]. This makes it difficult to fully mobilize students’

enthusiasm and initiative, resulting in low classroom participation, which further affects the improvement of teaching effects.

3.2. Disconnection between theoretical teaching and practical teaching

In the previous teaching of the “Circuit Theory” course, there was a disconnection between theory and practice. Teachers paid more attention to the teaching of theoretical knowledge but ignored the cultivation of students’ practical ability. As a result, although students could master professional basic theoretical knowledge, they found it difficult to apply it to actual circuit design, which hindered their future employment and development.

3.3. Imperfect evaluation system

The evaluation system of some colleges and universities is not perfect, and the evaluation results are difficult to fully reflect students’ comprehensive strength^[8]. The evaluation method is mainly based on paper-based test assessments, such as final exams and midterm exams, focusing on summative evaluation, while lacking attention to students’ dynamic learning process. To cope with exams, they have to adopt rote learning methods, making it difficult to truly master professional knowledge and skills. In addition, the evaluation standards are not comprehensive, mainly based on exam scores and project results, which are difficult to fully reflect students’ comprehensive strengths.

3.4. Outdated teaching content

Under the background of the Internet era, various new technologies, new concepts, and new equipment emerge one after another^[9]. However, the content of the “Circuit Theory” course in some colleges and universities has not been updated promptly, and the teaching content is outdated, leading to a disconnection between what students have learned and the development needs of enterprises, which hinders their future career development. In this regard, it is necessary for colleges and universities to keep up with the trend of the times, update teaching content promptly, and introduce emerging technologies such as the Internet of Things and big data into teaching to enrich teaching content and better meet students’ diverse needs.

4. Innovative strategies of the blended teaching model based on the Changjiang Rain Classroom

4.1. Pre-class preview: Use online resources to guide independent learning

4.1.1. Share preview materials

Changjiang Rain Classroom is an intelligent teaching tool integrating a variety of advanced technologies with rich functions. Teachers can push preview materials such as teaching videos, microcourses, and exercises to students through Changjiang Rain Classroom, helping them gain a preliminary understanding and cognition of the course content in advance and laying a foundation for improving teaching effects^[10].

4.1.2. Collect preview data

Rain Classroom also has powerful data collection functions, which can automatically collect students’ learning behavior data, such as online duration, exercise test accuracy, and video viewing duration. By analyzing these data, teachers can understand the preview situation of each student, and adjust course content and optimize teaching strategies based on this.

4.2. Classroom interaction: Combine Rain Classroom functions to deepen knowledge and understanding

4.2.1. Electronic check-in and random roll call

Teachers can use the electronic check-in function of Rain Classroom to let students scan the QR code to check in. In this way, teachers can effectively solve the attendance problem ^[11]. At the same time, a random roll call can be adopted to select students to answer questions. This not only can test students' mastery of professional knowledge but also can mobilize their enthusiasm, thereby improving classroom participation.

4.2.2. Bullet screen interaction and real-time Q&A

Teachers can also turn on the bullet screen function of Rain Classroom. Students can express their ideas and viewpoints at any time, and teachers can answer questions based on the main bullet screen content sent by students to improve teaching effects ^[12]. For example, when explaining the content of "sinusoidal steady-state circuits," many students raised questions in the bullet screen, such as "how to select reference vectors." In this regard, teachers can answer this question to help students break through learning difficulties.

4.3. Post-class consolidation: Expand online resources to strengthen practical ability

4.3.1. Online homework and automatic correction

Changjiang Rain Classroom also has the functions of assigning online homework and automatic correction. Teachers can use this function to issue after-class homework or project tasks to students. After completion, students can submit them online through Rain Classroom ^[13]. The platform can automatically correct the submitted homework and generate correction results. This not only greatly reduces the workload of college teachers and improves work efficiency but also helps students find their own shortcomings and prompts them to correct them promptly. At the same time, works can be displayed through Rain Classroom to lay a foundation for promoting communication and exchange among students.

4.3.2. Virtual simulation experiments

Changjiang Rain Classroom can provide virtual simulation experiment functions, which can create a realistic and virtual experimental scenario for students ^[14]. Through this platform, students can access various types of circuit models and conduct practical training in virtual scenarios to polish their skills. This can not only effectively reduce the cost of practical teaching, improve the safety and reliability of practical teaching, but also effectively cultivate students' practical ability and problem-solving ability. In addition, teachers can also timely understand students' practical situation through this platform and provide targeted guidance and help to them, thereby improving the effect and quality of practical teaching.

4.4. Assessment and evaluation: Build a diversified system to comprehensively evaluate abilities

Teaching evaluation is not only an important part of teaching activities but also an important channel for teachers to understand teaching effects and promote curriculum teaching reform ^[15]. In response to the imperfect evaluation system in traditional course teaching, colleges and universities and teachers should fully recognize the importance of teaching evaluation and build a sound evaluation system.

- (1) Enrich evaluation standards. In addition to grades and scores, students' innovative ability, teamwork ability, communication ability, etc., can also be included in the evaluation system to evaluate students

from multiple angles and levels, thereby improving the objectivity of evaluation results.

- (2) Adopt diversified evaluation methods. A combination of process evaluation and summative evaluation can be used to evaluate students, focusing not only on students' learning outcomes but also on their dynamic learning process. In this way, the accuracy of evaluation results can be improved.
- (3) Diversified evaluation subjects can be adopted. In the past, teachers often served as the evaluation subject, but teachers are easily affected by external factors, making the evaluation results lack objectivity. In this regard, in addition to teachers, students, enterprise experts, and other subjects can also be introduced as evaluation subjects. Through various methods such as student self-evaluation, peer evaluation, and enterprise evaluation, the accuracy of evaluation results can be improved.

5. Conclusion

In summary, under the background of “Internet +,” the blended teaching model based on Changjiang Rain Classroom provides a new direction and idea for the teaching reform of the “Circuit Theory” course. In this regard, teachers should fully recognize the value of blended teaching and, with the help of the powerful functions of Rain Classroom, adopt various methods and means to improve the teaching effect of the “Circuit Theory” course, more effectively cultivate students' professional literacy and comprehensive abilities, and lay a solid foundation for their comprehensive development in the future.

Disclosure statement

The authors declare no conflict of interest.

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Metaphorical Patterns and Translation Strategies of Business Negotiation Texts from the Perspective of Relevance Theory

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Abstract: Taking Relevance Theory as the core perspective, this paper focuses on the metaphorical patterns and translation strategies of business negotiation texts. The “ostensive-inferential” mechanism of Relevance Theory provides a cognitive logic for metaphor interpretation. By concretizing abstract business concepts, metaphors reduce the mental cost of negotiations and become a key link in cross-linguistic communication. This study examines the cognitive construction function of metaphors in business negotiation texts and proposes targeted translation strategies based on the core principles of Relevance Theory, aiming to enhance the accuracy and effectiveness of translation and facilitate smooth cross-cultural business communication.

Keywords: Relevance Theory; Business negotiation texts; Metaphorical patterns; Translation strategies

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1. Introduction

Business negotiation texts serve as a cross-cultural and cross-linguistic tool for interest mediation in commercial activities. Metaphors in these texts are not merely linguistic decorations but also powerful tools for conveying rich commercial meanings. Abstract topics such as profit distribution and risk avoidance are often expressed through metaphors, yet their interpretation and translation are easily influenced by context and culture, which may affect negotiation outcomes. Relevance Theory focuses on the principle of seeking optimal relevance in communicative activities, emphasizing achieving sufficient contextual effects with the minimum cognitive effort. This aligns perfectly with the contextual needs of effective communication in business negotiation texts. Based on this principle, this study explores the cognitive construction of metaphors in business negotiation texts and proposes targeted translation strategies, aiming to reduce cognitive errors and cultural conflicts in metaphor translation and improve the translation quality and communicative effectiveness of business negotiation texts.

2. Significance of metaphors and their translation in business negotiation texts from the perspective of relevance theory

2.1. Relevance theory provides cognitive logic for metaphor interpretation in business negotiation texts

Relevance Theory holds that linguistic communication is an ostensive-inferential process, where both parties need to find optimal relevance to understand the meaning of utterances. In business negotiation texts, metaphors are not just modifiers but also a way of thinking for expressing complex business objectives. In this conversational context, metaphors visualize abstract business concepts (such as profit sharing, cooperation models, and risk avoidance) into the scope of concrete perceptual experience, reducing the cognitive load of conceptual reasoning. From a relevance perspective, both parties in business negotiations must infer the information implied by metaphors based on the assumptions of the business conversational context to achieve optimal relevance. For example, equating “market” with “battlefield” not only indicates the nature of conflict but also implies deep-seated connotations such as resource plunder and strategic game. This decoding requires negotiators to have a clear grasp of the industry context, cultural context, and mutual needs. Relevance Theory provides a systematic cognitive framework for accurately capturing the meaning of metaphors, enabling negotiators to explore the deep commercial implications behind metaphorical forms ^[1-3].

2.2. Metaphor translation is a key link in achieving relevance transmission in business negotiations

As a form of cross-linguistic communication, metaphor translation is particularly important in business negotiations, directly affecting negotiation outcomes. Relevance Theory serves as the basic criterion for metaphor translation, guiding translation activities. The core of metaphor translation lies in reconstructing the cognitive relationship of metaphors in the target language, minimizing the cognitive effort of target language readers while enabling them to obtain the same potential information as source language readers ^[4]. If the translated metaphors fail to retain the cognitive relationship of the source language metaphors, it may lead to misunderstandings of negotiation objectives, information loss, or commercial confusion. Metaphor translation guided by Relevance Theory requires considering both the imagery of source language metaphors and the presentation methods of the target language, and selecting appropriate translation methods while maintaining contextual coherence. Through accurate metaphor translation, both negotiation parties can communicate based on a shared cognitive environment, avoiding relevance gaps caused by cultural differences and language barriers, ensuring the accurate and thorough transmission of negotiation information, and ultimately laying a good foundation for reaching consensus and establishing cooperation.

2.3. The relevance quality of metaphor translation affects business negotiation decision-making efficiency

In the decision-making link of business negotiations, the relevance quality of metaphor translation directly determines the accuracy of information transmission between both parties, thereby affecting decision-making efficiency. Relevance Theory emphasizes that translation should achieve a balance between cognitive effects and cognitive effort between the source language and the target language, that is, obtaining maximum contextual effects with minimal cognitive effort. When negotiations involve complex issues such as cooperation model innovation, metaphors are often used to simplify abstract logic. If the translation fails to construct equivalent relevance, it may lead to delays in the transmission of decision-making information. For example, if the source

language proposes “We hope to build an ‘ecological partner circle’ to achieve resource complementarity,” a literal translation of “ecological partner circle” may confuse the target language party due to the literal understanding of “ecology”; while translating it as “strategic partnership network for resource complementarity” in accordance with the principle of relevance can quickly help the other party grasp the core decision-making direction of “mutual benefit and resource integration,” reducing the cost of repeated communication. At the same time, high-quality metaphor translation can promote the consensus of negotiation decisions. In business negotiations, both parties often convey potential interest demands through metaphors, and translators need to use Relevance Theory to explore the decision-making intentions behind metaphors. When one party mentions “This cooperation is a ‘win-win chess game’”, the translation should not only retain the imagery of “chess game” (game and cooperation) but also highlight the decision-making orientation of “win-win,” enabling the other party to clearly understand the mutually beneficial nature of the cooperation. If the translation loses this relevance dimension, the other party may mistakenly judge it as a one-sided benefit proposal, delaying the decision-making process. It is evident that metaphor translation guided by Relevance Theory is not only a bridge for information transmission but also an important guarantee for promoting the efficient implementation of negotiation decisions and achieving win-win cooperation.

3. Metaphorical patterns of business negotiation texts from the perspective of relevance theory

3.1. Core connotation of relevance theory and its relevance fit with business negotiation texts

Proposed by Sperber and Wilson, Relevance Theory focuses on the “ostensive-inferential” communicative process, emphasizing the search for effective relevance to achieve smooth information transmission and meaning understanding^[5]. Optimal relevance refers to enabling the recipient to obtain sufficient contextual effects with the minimum cognitive effort. Business negotiation texts are typical social interaction texts, whose core goal is to facilitate the exchange of interests and agreement between both parties in transactions, which fully conforms to the social logic of Relevance Theory. Every piece of information conveyed in business negotiation texts does not exist independently; it can only be correctly interpreted when placed in various communicative contexts, such as negotiation context, mutual interest demands, and industry standards. As a cognitive tool, metaphors can transform abstract concepts to be conveyed by traders (such as profit and loss sharing, cooperation, and risk management) into vivid, concrete experiential domains, enabling both negotiation parties to quickly establish linguistic consistency and reduce cognitive friction in negotiations. For example, using “navigation” to refer to negotiations not only clearly presents the risks and choices faced in the negotiation process but also allows both parties to interpret the negotiation process in a shared cognitive environment, which helps improve the effectiveness of information processing and meets the cognitive requirements of optimal relevance proposed by Relevance Theory^[6].

3.2. Cognitive construction function of metaphors in business negotiation texts

From the perspective of Relevance Theory, metaphors play an important cognitive construction role in business negotiation texts, helping both negotiation parties construct cross-domain mappings. The specific content involved in business negotiation topics is abstract, complex, and prone to misunderstanding, such as “value exchange,” “cooperative competition”, and “compromise scale”. Directly using these terms may confuse the understanding between negotiating parties. The use of metaphors can fix abstract and complex

concepts in familiar concrete domains we have learned, simplifying our cognitive processing through similarity relationships. This cognitive construction is not arbitrary, but based on the principle of relevance; negotiators will select source domains most relevant to their negotiation goals and the other party's cognitive schema for metaphorical mapping. For example, using "partnership" to describe a cooperative relationship can trigger associations of "mutual assistance," "win-win cooperation," and "long-term stability," making it easy for both parties to quickly reach a cognitive consensus on the nature of cooperation; while using "dividing the cake" to metaphorize profit distribution clearly conveys connotations such as "fairness" and "proportionate distribution." In this way, the abstract thinking of negotiation topics is perceived through cognitive schemas, enabling both parties to quickly capture key information based on limited cognitive foundations and achieve an effective cognitive connection ^[7].

3.3. Dynamic adaptability of metaphorical patterns in business negotiation texts

Relevance Theory emphasizes the dynamics of cognitive environments, and the metaphorical patterns of business negotiation texts also need to be dynamically adapted to maintain optimal relevance. At different stages of negotiations, the power demands and core concerns of all parties are changing; adhering to initial metaphor choices may lead to comprehension barriers. For example, using "exploring the path" to metaphorize market research in the initial stage can express a cautious attitude of acting prudently. However, in the actual bargaining stage, the topic has shifted to specific cooperation details, and using metaphors like "exploring the path" will be inadequate. At this time, it is necessary to switch to metaphors expressing a constructive attitude, such as "building the framework" and "laying the foundation," which not only fit the current topic context but also help mobilize the other party's attention to the implementation of detailed clauses. Similarly, this flexibility is reflected in the impact on metaphor intensity. When negotiations reach a deadlock, using metaphors with clear behavioral orientations such as "breaking the ice" and "building bridges" can make both parties understand the need to jointly bear the increased difficulty of consultation and negotiation; after reaching a principled agreement, metaphors such as "irrigating" and "fertilizing" can be used to indicate the softening effect of long-term nurturing and accumulation. The dynamically adaptive metaphorical model actually modifies the mapping relationship between source domains and target domains with changes in the negotiation context, ensuring that each metaphor conveys the most meaningful information with the minimum cognitive cost. This is the ultimate explanation of Relevance Theory for the use of metaphors in business negotiations.

4. Translation strategies of business negotiation texts from the perspective of relevance theory

Language is one of the key factors in cross-cultural communication in business dialogues. The accuracy and precision of translation significantly affect information transmission and benefits. From the cognitive perspective of "epistemological relations" and "linguistic communication", Relevance Theory proposes that translation involves the original author, translator, and reader, and optimal relevance should be found to ensure effective information transmission. From this perspective, exploring translation strategies for business negotiation texts from the perspective of Relevance Theory can enhance the accuracy of language and effective communicative functions ^[8].

4.1. Based on cognitive context overlap, achieve accurate mapping of conceptual meanings

According to Relevance Theory, cognitive context is a synthesis based on three elements: individual encyclopedic knowledge, reasoning ability, and lexical memory, forming a unique cognitive domain. Therefore, whether the translated text can produce corresponding associative effects—that is, whether the recipient can restore a psychological response close to the original author within their cognitive domain—becomes an important criterion for evaluating translation success. Business negotiation documents often contain many terms, industry idioms, and situational attributes. Therefore, translators must first identify the cognitive overlap between negotiating parties to ensure the accurate transfer of conceptual meanings^[9]. When discussing issues involving trade, laws, and finance, the most important task is the deconstructive translation of proper nouns, which affects the smooth progress of the entire discussion. Using professional knowledge, translators identify the semantic orientation of a proper noun within a specific negotiation scenario, avoiding ambiguity or distortion caused by translation misunderstandings. For example, “force majeure” not only means “unforeseeable circumstances” but also requires examining specific industry clauses to clarify the division of responsibilities within the cognitive domain of target language readers.

4.2. Optimize the ostensive-inferential process, strengthen the relevance of information transmission

From the perspective of Relevance Theory, communicative activities consist of ostensive stimuli and inferential processes. The author of the original text conveys textual meaning and communicative intentions through ostensive stimuli, and the reader infers to find and locate the optimal relevance with the original text to understand the author’s implicature. In the process of converting business negotiation texts from one language to another, the translator acts as an “intermediary” to a certain extent. Therefore, translators should optimize the ostensive-inferential process, enhance the relevance of the translated text, and help target language readers obtain maximum benefits with the minimum inferential effort. At the ostensive level, translators need to reasonably arrange the information structure of the original text to make the translated text easy to understand and achieve efficient transmission. Sometimes, conventions or layout in the original language may lead to an unclear information hierarchy. In such cases, translators can split long sentences, adjust inverted structures to positive ones, place key information at the beginning of sentences, or use logical words to indicate the relationship between information. For example, long sentences commonly found in English negotiation texts need to be split into several short sentences, with logical relationships expressed through words such as “firstly,” “secondly,” and “therefore,” allowing readers to clearly grasp the main negotiation objectives and important clauses and reducing the burden of information processing. In addition, from an inferential perspective, translators should predict possible inferential paths based on the target readers’ knowledge reserve and add appropriate contextual cues to the text. For example, when business negotiation texts use business rules or implicit regulations related to a specific culture and business model, translators can incorporate annotations or adaptations to provide readers with a certain inferential foundation. However, additional information outside the main text should be kept concise to avoid increasing readers’ cognitive burden and hindering the coherence of the original text^[10].

4.3. Mediate cultural differences and conflicts, build a relevance bridge for cross-cultural communication

Business negotiations often involve negotiators from different cultural backgrounds, which may lead to

significant misunderstandings and hinder the final success of negotiations. Relevance Theory suggests that translators should be good at handling the tension between the source language and target language contexts, resolving cultural differences, and building cross-cultural communication bridges. In terms of value positions, different cultures have differences in business negotiation objectives and behavioral strategies. For example, Western cultures emphasize rationality and efficiency with straightforward discourse; Eastern cultures advocate interpersonal relationships and “face,” with subtle discourse^[11]. Therefore, translators must comprehensively consider these differences in the translation process and appropriately adjust the linguistic characteristics of individual texts. When translating direct views from English into Chinese, conciliatory or implicit expressions can be added to avoid offending readers with overly direct language. When translating implicit requests from Chinese into English, key content should be clearly expressed to conform to the thinking habits of English readers. Second, there are significant cultural differences in etiquette rules and expression forms^[12]. For example, greetings, thank-you remarks, and refusal expressions in business negotiations have certain cultural backgrounds. Therefore, translators should present the cultural context of the original text in a form familiar to target language readers to achieve the appropriateness of communicative etiquette. For example, the common Chinese expression “Jing qing hai han” in business negotiation documents can be translated into English as “we would appreciate your understanding,” which not only conveys the meaning of apology but also conforms to the communication model of English business negotiations.

4.4. Focus on negotiation goal orientation, and enhance the communicative effectiveness of the translated text

To achieve the goal of business negotiations, seeking a balance of interests and establishing cooperation, the translation of negotiation texts should be oriented towards negotiation objectives. Relevance Theory holds that the success of translation depends on whether the translated text can help readers achieve communicative goals. Translators need to strategically adjust the translated text around the core negotiation objectives to ensure that the translated information is highly relevant to the negotiation goals^[13].

In the initial intention communication stage of negotiations, text translation should be sufficient and directional, enabling participants to quickly understand each other’s cooperation intentions and plans. To this end, methods such as extracting topic sentences and removing redundant sentences can be used to allow participants to grasp the core of the negotiation in a shorter time, thereby laying the foundation for subsequent discussions.

In the mid-stage bargaining phase of negotiations, such as the conflict stage, a large amount of important information related to the interests, demands, and concessions of both parties is involved. Therefore, it is necessary to effectively convey key viewpoints and appropriately emphasize positions to enhance the other party’s acceptance. For example, when dealing with concession conditions in price negotiations, presenting a sincere attitude combined with bilateral trade-offs will help build trust and promote joint consultation between negotiating parties.

In the final contract formulation stage of negotiations, text translation requires higher professionalism and universality to ensure the legality and enforceability of contract clauses. Legal risks of contracts are caused by omissions in core content such as rights and responsibilities, violation disposal, and dispute resolution. Therefore, contract translators should carefully review key parts of the contract to prevent legal risks caused by translation issues. Negotiation goal-oriented translation methods can make the translated text not only a simple

information transmission tool but also contribute to the achievement of negotiation objectives, improving the communicative value of translation ^[14].

4.5. Dynamically adapt metaphorical imagery, retain the equivalence of cognitive relevance

The translation of metaphors in business negotiation texts is a key link in relevance transmission. It is necessary to dynamically adapt metaphorical imagery in the target language to ensure the equivalence of cognitive relevance between the source language and the target language. According to Relevance Theory, the translation of source language metaphors should not only involve their literal meanings but also reveal their deep metaphorical thinking, avoiding relevance breakdown caused by imagery misunderstandings. If the source language metaphorical schema lacks corresponding cognitive counterparts in the target language cultural context, translating the original metaphor directly will cause excessive cognitive effort for readers. In such cases, the “image construction” strategy can be adopted. For example, the English metaphor “to fish in troubled waters” (hun shui mo yu) is literally translated as “zai hun shui zhong mo yu” in Chinese, but Chinese readers may struggle to infer the metaphorical schema of “taking advantage of disorder and getting unjust benefits.” Therefore, translating it as the common Chinese metaphor “hun shui mo yu” not only adheres to the core cognitive schema but also conforms to target language expression habits ^[15]. If the source language and target language metaphors have similar schemas but different connotations, the “content supplement” strategy can be used. For example, the Chinese metaphor “da chi jiu zhan” in negotiations not only has the basic meaning of “long-term tenacity” but also implies the negotiation intention of “strategic consumption” contained in its metaphorical schema; when translated into English as “to fight a protracted war”, contextual supplements such as “to maintain strategic patience in the context of negotiation” should be added to help readers grasp this negotiation intention. This dynamic adaptation, centered on relevance, not only maintains the vividness of metaphors but also enables target language readers to obtain contextual effects equivalent to those of source language readers with the maximum cognitive effort, achieving the accurate transmission of deep commercial intentions implied by metaphors in negotiations.

5. Conclusion

Relevance Theory provides a systematic cognitive framework for the interpretation and translation of metaphors in business negotiation texts. As an important cognitive tool in business negotiations, the effective transmission of metaphors is crucial for achieving negotiation goals. The four translation strategies proposed in this study, based on cognitive context, optimizing ostensive-inferential processes, mediating cultural differences, and focusing on negotiation goals, both follow the core principles of Relevance Theory and fit the actual needs of different stages of business negotiations. By applying these strategies, translators can better handle the metaphorical patterns in business negotiation texts, improve translation accuracy and relevance, and promote the smooth progress of cross-cultural business negotiations.

Disclosure statement

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Research on the Educational Cooperation Paths Between China and Countries Along the Danube River

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Abstract: As an important link for the extension of the “Belt and Road” Initiative in Europe, countries along the Danube River have achieved remarkable results in educational cooperation with China, becoming a key practice in building the “Belt and Road” Education Community. This paper systematically explores the educational cooperation paths between China and countries along the Danube River. Research shows that, driven by the dual mechanisms of the “Belt and Road” Initiative and the “China-CEEC Cooperation,” bilateral educational cooperation has formed a diversified pattern characterized by joint education programs, teacher-student exchanges, language and cultural communication, and industry-university-research collaboration. However, the current cooperation still faces challenges such as insufficient sustainability, mismatched supply and demand of educational resources, and institutional and cultural barriers. To promote the cooperation towards high-quality development, this paper proposes that efforts should be made to improve the long-term cooperation mechanism and quality assurance system, expand new areas of industry-university-research integration and digital cooperation, and provide sustained impetus for deepening bilateral educational cooperation and cultivating international talents by optimizing resource allocation, strengthening teacher team construction, and building a multi-level cooperation network.

Keywords: Countries along the Danube River; “Belt and Road” Initiative; Educational internationalization

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1. Introduction

As the second-longest river in Europe, the Danube flows through 9 countries, including Germany, Austria, Hungary, and Slovakia, connecting Central-Western Europe and Southeast Europe with a unique geographical location. It serves as an important link for the extension of the “Belt and Road” Initiative in Europe. In recent years, with the in-depth advancement of the China-Central and Eastern European Countries (CEEC) Cooperation Mechanism (“16 + 1 Cooperation”) and the full implementation of the “Belt and Road” Initiative, educational cooperation between China and countries along the Danube River is in a critical stage

of transformation from scale expansion to quality improvement^[1]. Systematically sorting out the current status of cooperation, analyzing existing problems, and exploring optimization paths are of important theoretical and practical significance for deepening educational cooperation and building a more dynamic education community. This study will comprehensively discuss the background, foundation, current characteristics, challenges, and development paths of educational cooperation between China and countries along the Danube River.

2. Cooperation background and foundation

2.1. Policy support

The vigorous development of educational cooperation between China and countries along the Danube River benefits from the top-level design and policy support jointly promoted by both parties. The full implementation of the “Belt and Road” Initiative has provided strategic guidance for educational cooperation. In 2013, the Chinese government proposed the “Belt and Road” Initiative, establishing a cooperation framework covering Asia, Europe, and Africa. As an international river running through Europe, the Danube has naturally become an important link for the extension of this initiative in Europe^[2].

Meanwhile, the China-CEEC Cooperation Mechanism (“16 + 1 Cooperation”) has provided an institutionalized platform for educational cooperation. Since its launch in 2013, this mechanism has become an important platform for promoting cooperation between China and CEECs, including countries along the Danube River. Under this mechanism, educational and cultural exchanges have been identified as priority areas of bilateral cooperation, promoting joint talent training, inter-university cooperation, and scientific research collaboration through institutionalized arrangements.

Countries along the Danube River have also actively responded to these initiatives. For example, Hungary, Serbia, Romania, and other countries have actively participated in cooperation. These policy interactions have created a favorable environment for educational cooperation, promoting the sharing and complementary advantages of educational resources between the two parties^[3].

2.2. Practical needs

China and countries along the Danube River have obvious complementary advantages in the field of education, providing a solid foundation for cooperation. CEECs have traditional advantages in professional fields such as engineering education, art design, and medicine, while China has accumulated rich experience in information technology, economic management, and infrastructure construction. This complementarity provides a broad space for bilateral educational cooperation, enabling both parties to achieve win-win results through cooperation.

With the increasingly close economic and trade relations between China and CEECs, the structure of talent demand has also changed. According to data from Eurostat, the internationalization level of higher education in countries along the Danube River has continued to improve, with the proportion of international students exceeding 15% in countries such as Hungary, Austria, and Slovakia^[4]. China has become one of the world’s largest exporters of international students. This two-way flow demand has created a broad space for educational cooperation. Especially against the background of Chinese-funded enterprises increasing investment in CEECs, there is an urgent shortage of compound talents who understand both Chinese and professional knowledge.

In addition, the internationalization needs of the education systems in countries along the Danube River are aligned with China's strategy of "going global" in education. Hungary, Serbia, Romania, and other countries have signed agreements on the mutual recognition of higher education academic qualifications and degrees with China, removing institutional barriers for deepening cooperation. These countries generally hope to improve the internationalization level of education by attracting Chinese students and carrying out joint education programs, while China also hopes to further integrate into the European Higher Education Area, improve educational quality and international influence through cooperation with these countries.

3. Analysis of current cooperation status

3.1. Main models and characteristics

At present, educational cooperation between China and countries along the Danube River has formed a diversified and multi-level development pattern, mainly reflected in the following aspects:

(1) Joint education programs have developed steadily

In recent years, Chinese universities have collaborated with universities in countries along the Danube River to launch a series of joint education programs covering undergraduate, master's, and other levels. For example, East China Normal University has cooperated with Budapest Business School in Hungary to carry out economic management talent training programs, which focus on integrating Eastern and Western management wisdom to cultivate business talents with a global perspective.

(2) Teacher-student exchanges and short-term programs have become increasingly active

Chinese universities and universities in countries along the Danube River have carried out a variety of teacher-student exchange and short-term study programs, such as summer schools and micro-study abroad programs. The summer credit courses cooperated by Peking University and the University of Vienna in Austria provide students from both universities with the opportunity to study at top European universities. Through special lectures, cultural experiences, language practice, and other forms, such programs have broadened students' international horizons and improved their cross-cultural communication skills^[5].

(3) Language teaching and cultural promotion have achieved remarkable results

Chinese education in countries along the Danube River has developed rapidly, especially in Hungary, which is in a leading position among CEECs. The Hungarian-Chinese Bilingual School has established a Confucius Classroom in cooperation with Capital Normal University and High School Affiliated to Capital Normal University. The school currently has 20 classes in 12 grades with more than 530 students, cultivating a large number of outstanding Chinese-speaking talents for Hungary.

(4) Industry-university-research cooperation has gradually deepened. In educational cooperation, China and countries along the Danube River focus on integrating with industries and promoting the transformation of scientific research results^[6]. In September 2025, the "2025 China-CEEC Industry-University-Research Cooperation Matching Conference" held in Nanjing provided a platform for cooperation between the two parties in technology transfer, joint R&D, and talent exchange.

3.2. Existing problems and challenges

Despite the remarkable achievements in educational cooperation between China and countries along the Danube

River, there are still some prominent problems and challenges:

(1) The depth and sustainability of cooperation need to be strengthened

At present, bilateral educational cooperation is still dominated by short-term projects and primary cooperation, lacking long-term strategic and in-depth cooperation. For example, some joint education programs are small in scale and have limited influence. In addition, the cooperation quality evaluation and assurance mechanism are not sound, affecting the sustainable development of cooperation.

(2) There is a mismatch between the supply and demand of educational resources

Differences exist between China and countries along the Danube River in educational concepts, curriculum settings, and teaching methods, leading to frequent resource mismatches in cooperation^[7]. For example, the Chinese side focuses on the systematic teaching of professional knowledge, while the Danube countries emphasize the cultivation of critical thinking and innovative abilities. These differences have caused practical difficulties in curriculum alignment, credit transfer, and academic recognition, affecting the in-depth development of cooperation.

(3) Institutional and cultural barriers still exist

Countries along the Danube River have prominent linguistic diversity. In addition to English, the shortage of talents proficient in non-common languages such as Hungarian, Slovak, and Croatian has restricted the breadth and depth of educational cooperation. There are also differences between the two parties in educational management systems, quality evaluation standards, and academic certification mechanisms, increasing the difficulty of cooperation^[8,9].

4. Exploration of cooperation paths

4.1. Improve cooperation mechanisms and enhance cooperation quality

To promote the sustainable development of educational cooperation between China and countries along the Danube River, it is necessary to establish and improve long-term cooperation mechanisms and enhance cooperation quality.

(1) Strengthen strategic planning and policy alignment

Both parties should strengthen dialogue on educational development strategies and policy communication, jointly formulate medium and long-term cooperation plans, and clarify cooperation goals, key areas, and priority directions. Chinese educational authorities can establish a regular consultation mechanism with the Ministries of Education of countries along the Danube River to promptly resolve policy barriers arising from cooperation^[10].

(2) Build a multi-level cooperation network

Encourage the formation of synergy between the central and local governments, governments and civil society, and schools and enterprises to build a multi-level and wide-coverage educational cooperation network^[11]. The central government strengthens top-level design and policy support, local governments carry out targeted cooperation projects in combination with local characteristics and needs, schools play the main role, and enterprises provide industry support and employment channels, forming a cooperation model closely integrating industry, university, research, and application.

(3) Establish a quality assurance and evaluation mechanism

Jointly develop educational quality standards and evaluation indicators applicable to both parties,

and establish a sound whole-process quality assurance mechanism for cooperation projects. Conduct regular evaluations of joint education programs, joint scientific research projects, teacher-student exchange programs, etc., to ensure cooperation quality. At the same time, establish a cooperation information sharing platform to timely release cooperation dynamics and successful cases, improving the transparency and credibility of cooperation.

4.2. Expand cooperation areas and innovate cooperation forms

Facing the trend of educational internationalization in the new era, China and countries along the Danube River should continuously expand cooperation areas and innovate cooperation forms.

(1) Promote in-depth integration of industry, university, and research

Combine the industrial development needs of both parties to promote the close integration of educational cooperation with industrial upgrading and technological innovation. Encourage universities and enterprises to jointly build joint laboratories, technology transfer centers, and industrial research institutes to promote the transformation of scientific and technological achievements and talent training ^[12,13].

(2) Expand online education and cooperative research

Actively embrace digital transformation, and vigorously develop new educational cooperation models such as online education, virtual classrooms, and remote cooperation. Jointly develop online courses and digital educational resources to promote the sharing of high-quality educational resources. Establish joint research platforms, encourage scholars to carry out cooperative research, jointly apply for international scientific research projects, and improve scientific research and innovation capabilities.

(3) Enrich cultural exchanges and language cooperation

On the basis of existing Chinese teaching, further expand the depth and breadth of cultural exchanges. Promote mutual understanding and appreciation of cultures between the two parties through cultural festivals, art exhibitions, academic forums, and other forms. While promoting Chinese teaching, strengthen the teaching of CEEC languages in China to cultivate multilingual talents.

4.3. Optimize resource allocation and strengthen guarantee measures

To ensure the sustainable development of educational cooperation, it is necessary to optimize resource allocation and strengthen guarantee measures.

(1) Increase resource investment

Governments of both parties should increase financial support for educational cooperation, establish special funds to provide stable financial guarantees for cooperation projects, teacher-student exchanges, scientific research cooperation, etc. At the same time, encourage social forces such as enterprises and foundations to invest resources, forming a diversified investment mechanism.

(2) Strengthen the teacher team construction

Attach importance to the training and development of teachers, and improve their internationalization level and cross-cultural teaching capabilities. Build a high-quality international teacher team through teacher exchanges, joint teaching and research, professional development training, and other methods. Especially for joint education programs, attention should be paid to the participation of foreign teachers and the capacity building of Chinese teachers to ensure teaching quality ^[14,15].

(3) Build a partnership network

Encourage universities, scientific research institutions, enterprises, and other entities to establish multi-level partnerships and form a cooperation network. Promote resource sharing and experience exchange through organizational forms such as “university alliances” and “professional associations.” For example, a “China-Danube University Alliance” can be established to regularly hold presidential forums, academic conferences, cultural festivals, and other activities to enhance cooperation and cohesion.

5. Conclusion

Educational cooperation between China and countries along the Danube River has become an important part of the construction of the “Belt and Road” Education Community. After years of development, bilateral cooperation has achieved remarkable results, forming a diversified and multi-level cooperation pattern, and building a cooperation network involving both government and civil society with multi-party participation. The cooperation areas are constantly expanding, and the cooperation content is increasingly enriched, making positive contributions to promoting bilateral people-to-people exchanges and economic and trade cooperation.

Looking forward to the future, educational cooperation between China and countries along the Danube River should further strengthen the concept of win-win cooperation, highlight quality orientation, and innovate cooperation models, focusing on deepening cooperation in the following aspects:

- (1) Strengthen strategic alignment, promote the transformation of cooperation connotation from scale expansion to quality improvement, and build a more complete quality assurance system. Both parties should strengthen educational policy communication and development strategy alignment, jointly formulate medium and long-term development plans for educational cooperation, and establish and improve institutional frameworks such as academic degree mutual recognition, credit transfer, and quality certification to create a more favorable policy environment for educational cooperation.
- (2) Expand cooperation areas, extending from language and culture to broader fields such as technological innovation and vocational training. Fully tap the cooperation potential of both parties in fields such as engineering and technology, biomedicine, environmental science, and digital economy, and promote the in-depth integration of educational cooperation with technological innovation and industrial upgrading. At the same time, vigorously develop vocational education cooperation to jointly cultivate high-quality technical and skilled talents.
- (3) Innovate cooperation models, make full use of information technology, and develop new cooperation forms such as online education and virtual teaching and research. Actively embrace the digital wave and promote the digital transformation of educational cooperation models. Jointly develop online courses, virtual laboratories, digital libraries, and other educational resources to promote the sharing and efficient use of high-quality educational resources.

As a cultural corridor connecting eastern, western, southern, and northern Europe, the Danube has historically been a channel for the integration and mutual learning of different civilizations. Under the framework of the “Belt and Road” Initiative and China-EU comprehensive strategic partnership, educational cooperation between China and countries along the Danube River is expected to become a model for cross-regional educational cooperation. The two parties will cultivate more outstanding talents with global perspectives, cross-cultural understanding, and international cooperation capabilities, contributing educational strength to building a community with a shared future for mankind.

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Research on the New Models and Practical Dilemmas of Middle School Chinese Classroom Teaching Under Technology Empowerment

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Abstract: Against the background of the rapid development of digital technology, the integration of technology in the field of education has become an inevitable trend, and middle school Chinese classroom teaching has also ushered in an important opportunity for model innovation. Technology empowerment has injected new vitality into middle school Chinese teaching, promoting the formation of various new teaching models such as contextualized teaching, personalized learning, and interactive discussion, which have effectively expanded the boundaries and dimensions of Chinese teaching. However, in the practice process, middle school Chinese teaching under technology empowerment also faces many dilemmas, such as insufficient adaptability between technology application and the essence of Chinese teaching, an imbalance between teachers' technical literacy and teaching needs, scattered students' learning attention, and homogenization of teaching resources. This paper deeply explores the new models of middle school Chinese classroom teaching under technology empowerment, analyzes the dilemmas encountered in practice, and puts forward corresponding countermeasures, aiming to provide a useful reference for promoting the in-depth integration of technology and middle school Chinese teaching.

Keywords: Technology empowerment; Middle school Chinese; New teaching models; Practical dilemmas; Countermeasures

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1. Introduction

Chinese is a core course in middle school. While undertaking the educational function of language and characters, it also assumes important functions such as cultural inheritance, thinking construction, and aesthetic education^[1]. In recent years, with the continuous popularization of information technology, various technical forms such as big data, artificial intelligence, and multimedia have been introduced into the field of education and teaching, which provides a strong technical guarantee for promoting the reconstruction and reform of middle school Chinese classroom teaching. Technology empowerment is by no means a simple application of

technology; it is a process of organically integrating technology with the teaching content, teaching methods, and teaching ideas of middle school Chinese through technology integration, thereby reconstructing and optimizing the teaching process and improving teaching effectiveness. In the field of middle school Chinese teaching, the application and integration of technology have broken the time and space constraints of traditional teaching, innovated the presentation forms of teaching content and methods, and provided students with more diverse learning scenarios^[2].

2. Core presentation of new models of middle school Chinese classroom teaching under technology empowerment

2.1. Contextualized teaching model: Strengthening the sense of experience in Chinese learning

Emotions, ideas, and culture in language and characters are the fundamental content of Chinese learning and appreciation, and the understanding of emotions, ideas, and culture often needs to be supported by relevant contexts. In the process of constructing teaching contexts in the past, teachers mainly built contexts through language introduction, picture display, and key-point emphasis, which were difficult to promote students' direct contact and perception with the contexts. With technology empowerment, a broad world and approaches have been opened up for the in-depth contextual construction of Chinese courses, promoting the continuous evolution and development of situational and immersive contextual teaching. In the context of text teaching, teachers can play corresponding voices and videos through multimedia tools, shifting the understanding of the relevant content of the text from superficial textual images to vivid textual and auditory information; in the context of narrative text teaching, they can play clips of films, animations, etc., related to the text content, allowing students to quickly associate and immerse themselves in the plot, and enhance their understanding of the text's implication^[3].

2.2. Personalized learning model: Adapting to students' differentiated needs

There are obvious individual differences in the cognitive level, learning ability, and learning interests of middle school students. The traditional "one-size-fits-all" teaching model is difficult to meet students' differentiated learning needs, and it is easy to lead to the polarization of learning effects. Under technology empowerment, the application of big data technology and intelligent learning platforms has made it possible to construct a personalized learning model, realizing the implementation of the "student-centered" teaching concept^[4]. Intelligent learning platforms can accurately analyze students' learning status by recording their learning behavior data, such as learning duration, answer situation, and error distribution, clarifying students' strengths and weaknesses in mastering Chinese knowledge and improving their abilities. Based on these analysis results, the platform can push personalized learning resources and tasks for students. At the same time, the personalized learning model also provides students with a flexible learning rhythm and methods. Students can arrange their learning time independently according to their own situation, carry out learning anytime and anywhere through online platforms, and repeatedly watch teaching videos and consult relevant materials for unfamiliar knowledge points until they fully master them^[5].

2.3. Interactive discussion model: Improving classroom participation and thinking depth

In traditional middle school Chinese classrooms, teacher-student interaction is mostly manifested as one-way or

two-way interaction where teachers ask questions and students answer. There is relatively little communication and discussion among students, making it difficult to fully mobilize students' thinking and enthusiasm. Under technology empowerment, the application of technical means such as online interactive platforms and instant messaging tools has constructed a multi-directional interactive discussion-based teaching model, making classroom interaction more efficient and in-depth^[6]. In classroom teaching, teachers can issue discussion topics through online interactive platforms, and students can submit their views and ideas in real time through the platform. The platform can summarize and display students' speeches, facilitating teachers and students to intuitively understand different viewpoints, and then guide students to conduct in-depth discussions. In addition, the interactive discussion model can also be extended to after-class. Students can continue to discuss unresolved classroom issues through online learning communities, share relevant learning materials they have found, and teachers can participate in guidance and enlightenment at any time, realizing the organic connection between classroom teaching and after-class learning, and further cultivating students' independent thinking ability and cooperative inquiry ability.

3. Practical dilemmas of middle school Chinese classroom teaching under technology empowerment

3.1. Insufficient adaptability between technology application and the essence of Chinese teaching

The essence of Chinese teaching lies in the learning of language and characters, the cultivation of thinking ability, the improvement of aesthetic taste, and the inheritance of cultural connotation, with its core being the understanding and perception of “form” and “meaning.” However, in the practice of technology-empowered Chinese teaching, some teachers believe that the integration of technology and Chinese disciplines is the teaching of technology application itself rather than Chinese education, making technology “dominate the guest” and move away from the origin of Chinese education. Some teachers focus on technology “showmanship” in Chinese classroom teaching^[7], presenting one “material” after another, such as “picture guessing games,” playing long video clips one after another, and showing animations one after another. The classroom is driven by lively, noisy, and intense audio-visual and situational experiences. Teachers focus a lot on vision and hearing, but forget or ignore the interpretation of the text itself. The “blank space” of the text that should be emphasized is lost for students, and students do not shift their attention to the text itself. The emotions and thoughts that teachers should focus on are forced to be transferred to extracurricular education. A large number of technical processing methods in the classroom have brought a lot of impact to the originally relatively clear Chinese courses, moving further away from the essence of Chinese education^[8].

3.2. Imbalance between teachers' technical literacy and teaching needs

Teachers are the main body of technology-empowered Chinese teaching, and their own technical literacy restricts the process of in-depth integration and development of technology and Chinese teaching. However, the overall technical literacy of current middle school Chinese teachers cannot meet the needs of technology-empowered teaching development and is mismatched with the development of technology-empowered Chinese teaching. First, some young and middle-aged teachers are greatly influenced by traditional teaching concepts, are unable to accept new technologies well, are unwilling to learn technologies, and can only perform simple operations, such as making and playing multimedia courseware. They cannot use cutting-edge technologies

such as intelligent learning platforms and interactive discussion tools to carry out teaching activities, making it impossible to implement the teaching model of technology-empowered Chinese teaching^[9]. Second, although some young teachers have mastered various technical operations, technology and teaching cannot be organically combined. They can skillfully operate various technical tools, but they do not select appropriate technical means according to the characteristics and teaching needs of Chinese teaching, and cannot organically integrate Chinese teaching and Chinese technology. Technology and teaching cannot be effectively and organically integrated, leading to technology-empowered Chinese teaching becoming a form of superficial technology^[10].

3.3. Scattered students' learning attention and insufficient learning depth

While technology provides students with rich learning resources and diverse learning experiences, its entertaining and interactive characteristics are likely to distract students' learning attention, leading to insufficient learning depth. This problem is particularly obvious in middle school Chinese classroom teaching. On the one hand, when using technical tools such as multimedia equipment and intelligent terminals, some students are easily attracted by the entertainment functions and network information in the equipment, such as secretly browsing web pages, playing games, and chatting in class, resulting in their attention being separated from the teaching content and affecting the classroom learning effect. Even with teachers' supervision, it is difficult to completely avoid such problems, increasing the difficulty of classroom management. On the other hand, the fragmented learning resources and convenient information acquisition methods provided by technology have weakened students' in-depth thinking ability to a certain extent^[11].

4. Ideas for addressing the dilemmas of technology-empowered middle school Chinese teaching

4.1. Adhere to the essence of Chinese teaching and realize precise technology empowerment

Technology is an auxiliary means of teaching, not the main body. In technology-empowered middle school Chinese teaching, first of all, teachers must adhere to the essence of Chinese teaching and adhere to the purpose of technology empowerment to improve efficiency and quality, and cultivate students' core Chinese literacy^[12]. The selection of technical means and the design of teaching processes should be based on Chinese teaching content. According to teaching objectives, key and difficult points, and students' actual learning situation, select technical tools that match the teaching content, avoiding the mechanical application of technology and simple stacking of technologies. For example, in text interpretation teaching, the teaching objectives should be achieved mainly through teachers' organization and guidance, and students' independent reading and discussion. Only when it is necessary to create contexts and help students understand the text, multimedia, VR, and other technical means should they be appropriately used; in writing teaching, intelligent writing platforms can be used to push writing materials for students and provide services such as grammatical error correction for students. However, the core of writing teaching should still be students' learning of thematic conception, language expression, and logical sorting. By closely combining technology with the essence of Chinese teaching, precise technology empowerment can be realized, and technology can truly serve the improvement of Chinese teaching quality^[13].

4.2. Strengthen teacher training and improve technical literacy and integration ability

Improving Chinese teachers' technical literacy is the foundation for using technology to empower middle school Chinese teaching. Schools should build an effective teacher training model and carry out hierarchical and

classified training for Chinese teachers of different age groups and technical literacy levels. For older Chinese teachers, basic technical operation training should be carried out to enable them to master the operation of some basic technical tools such as multimedia courseware and intelligent learning platforms, eliminating their fear or resistance to technology application; for younger Chinese teachers, training on the integration ability of technology and teaching should be carried out to guide them to think about the value of integrating technology with Chinese teaching and improve their ability to integrate technology with Chinese teaching content and methods. Schools should also provide an interactive communication platform for Chinese teachers, encouraging and guiding them to exchange experiences and insights on technology-empowered Chinese teaching, conduct collective lesson preparation, teaching seminars, and other activities, and enhance teachers' technical literacy through mutual learning, communication, and discussion; at the same time, teachers themselves should establish the concept of lifelong learning, actively understand the latest trends of integrating information technology with education and teaching, learn advanced technologies and concepts in a timely and targeted manner, and continuously improve their own quality and accomplishment^[14].

4.3. Strengthen student guidance and cultivate independent learning and in-depth thinking abilities

In response to problems such as scattered learning attention and insufficient learning depth caused by technology for students, teachers should strengthen student guidance, cultivate students' independent learning ability and in-depth thinking awareness, strengthen classroom management of students in classroom teaching, formulate certain teaching standards for the use methods and requirements of technical tools, make clear requirements for technology use, and keep students focused on the teaching content through arranging appropriate learning tasks and creating teaching interactions. When guiding students to use network resources for learning, it is necessary to cultivate students' skills in retrieving effective resources and improve their information literacy^[15]. Strengthen the cultivation of students' independent thinking awareness, allowing students to learn to use their own awareness and thinking to solve problems independently when encountering questions and doubts, and only try to use relevant information from technical means to solve problems when they encounter difficulties, supplementing rather than directly searching for answers on the Internet. For example, in the process of text interpretation, let students conduct independent text interpretation first, write down their initial understanding of the text, and then find text interpretation materials through the Internet to compare and reflect on the differences in their own views, so as to understand the text more deeply and systematically. By strengthening guidance to students, students can make reasonable use of technical means for learning and enhance the depth of learning.

5. Conclusion

Technology empowerment has promoted the reform of middle school Chinese teaching, spawned new teaching forms such as contextualized, personalized, interactive, and resource-expanded teaching, greatly enriched the space and dimensions of Chinese teaching, and provided a new paradigm for improving the quality and efficiency of middle school Chinese teaching. Technology empowerment in middle school Chinese teaching also faces many problems such as mismatched technology and teaching nature, unbalanced technical application of teachers, and low quality of students' learning. To solve the above problems, it is necessary to firmly adhere to the essence of Chinese teaching, give full play to technology-empowered education for precise empowerment; improve teachers' technical application literacy to promote the in-depth integration of technology and teaching;

improve students' technical application literacy to promote students' in-depth learning.

Disclosure statement

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The Relationship Between Family Parenting Styles and Willpower in 3 + 2 Continuous Education Medical Students: A Survey Study

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Abstract: This study investigated the mechanism through which family parenting styles influence the willpower of 1,442 medical students from the 2020 to 2025 cohorts in a five-year 3 + 2 continuous education program at a health school in Qingdao, using a questionnaire survey. Findings revealed that the students' overall willpower was relatively strong. Students who did not hold any class cadre or club positions had lower willpower levels. First- and second-year secondary vocational students demonstrated stronger willpower, and Stomatology majors exhibited significantly higher willpower than other majors. A harmonious parental relationship significantly and positively predicted students' willpower levels, whereas permissive and indulgent parenting styles were significant negative predictors. Recommendations for cultivation are proposed from the perspectives of the students themselves, the family environment, and school education.

Keywords: 3 + 2 continuous education medical students; Family parenting styles; Willpower

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1. Introduction

Secondary vocational and technical education is a vital component of China's modern education system, with its core mission being the cultivation of technical and skilled talents possessing strong practical operational abilities^[1,2]. Secondary vocational students, as a specific group within vocational education, are generally younger and at a critical stage of ideological maturation. They often exhibit characteristics such as weak willpower and insufficient self-control in their daily academic lives^[3,4], while simultaneously facing dual pressures from further education and employment. Therefore, enhancing the willpower quality of secondary vocational students is an imperative requirement for cultivating practical technical talents in the new era.

Modern Chinese psychologist Professor Zhu Zhixian posits that will is a complex psychological process through which humans consciously establish goals, actively regulate their own behaviors, and overcome

obstacles to achieve predetermined objectives^[5]. In this process, willpower manifests across four key dimensions: Consciousness (clear cognition of goals and internal drive), Decisiveness (swift and firm action in decision-making), Perseverance (tenacity to maintain sustained effort in adversity), and Self-control (capacity to control impulses and emotions to maintain focus). These core characteristics collectively constitute the stability of an individual's will, which is crucial for 3 + 2 continuous education medical students to maintain determination and resilience in pursuing long-term goals.

2. Research methods

2.1. Participants

This study employed a stratified sampling method, selecting all medical students from the first to fifth years (2020 to 2024 cohorts) of the five-year 3 + 2 continuous program at a secondary vocational health school in Qingdao, totaling 1,442 students.

2.2. Instruments

2.2.1. Self-compiled basic information questionnaire

This included: (1) student personal information (gender, grade, major, student role); (2) family relationship perceptions (primary influential caregiver, most trusted family member, parenting style of the primary caregiver, parental marital relationship status).

2.2.2. Middle school student willpower scale

This scale, developed by Professor Liang Chengmou^[6], is a commonly used psychological instrument for assessing the willpower level of middle school students. The scale consists of 20 items rated on a 5-point Likert scale from “Strongly Agree” to “Disagree” (scored 1 to 5), with a maximum score of 100. It contains 10 forward-scored and 10 reverse-scored items. The scale comprises four dimensions: Purposefulness, Consciousness, Decisiveness, Perseverance, and Self-control. Scoring criteria: 81–100 (very strong willpower), 61–80 (relatively strong), 41–60 (average), 21–40 (relatively weak), 0–20 (very weak). In this study, the scale demonstrated good internal consistency reliability (Cronbach's $\alpha = 0.796$) and structural validity (KMO = 0.896), meeting psychometric standards.

2.3. Survey method

The questionnaires were integrated on the Wenjuanwang platform, distributed via QR codes to classes. Class academic monitors were trained beforehand on the instructions, and then organized their classmates to complete the survey online anonymously in a unified manner.

2.4. Data analysis

Data were processed on the SPSSPRO platform within Wenjuanwang, involving data cleaning, reverse-scoring, and statistical analysis, including descriptive statistics, *t*-tests, chi-square tests, and ANOVA.

3. Results

3.1. Basic information

A total of 1446 questionnaires were distributed, with 1442 valid responses recovered (248 males, 1194 females). Specific demographic characteristics are shown in **Table 1**.

Table 1. Basic information statistics of students

| Category | Option | Frequency | Percentage (%) |
|--------------|--------------------------------------|-----------|----------------|
| Gender | Female | 1194 | 82.802 |
| | Male | 248 | 17.198 |
| Student Role | Holds no above positions | 880 | 61.026 |
| | Student Cadre | 368 | 25.520 |
| | Both Student Cadre and League Member | 112 | 7.767 |
| | League Member | 82 | 5.687 |
| Major | Nursing | 922 | 63.939 |
| | Pharmacy | 256 | 17.753 |
| | Rehabilitation | 120 | 8.322 |
| | Stomatology | 77 | 5.340 |
| | Medical Imaging | 66 | 4.577 |
| | Midwifery | 1 | 0.069 |
| Grade | College Year 1 | 479 | 33.218 |
| | Secondary Vocational Year 2 | 473 | 32.802 |
| | Secondary Vocational Year 1 | 399 | 27.670 |
| | Secondary Vocational Year 3 | 70 | 4.854 |
| | College Year 2 | 21 | 1.456 |
| | Total | 1442 | 100.000 |

The primary caregivers perceived by students as having the most educational influence were, in order: mother (69.764%), father (18.863%), others (7.004%), grandparents (4.369%). The perceived parenting styles were: democratic (80.791%), strict (13.523%), permissive (2.427%), and indulgent (1.456%). The parental relationship types were: harmonious (85.922%), distant (6.588%), tense (4.716%), and uncertain (2.774%).

3.2. Descriptive analysis

The means and standard deviations of the four willpower factors were ranked (**Table 3**). The overall mean willpower score was 60.474, indicating relatively strong willpower. Significant differences existed among the four factors ($p < 0.01$), ranked high to low: Consciousness (3.839 ± 0.754), Perseverance (3.763 ± 0.881), Decisiveness (2.799 ± 0.882), and Self-control (1.659 ± 0.613). Significant polarization was observed in the total score and all factors.

3.3. Difference analysis

3.3.1. Gender differences

Independent samples t-tests revealed significant gender differences in Consciousness, Decisiveness, and Perseverance. Females had higher Decisiveness (2.817 ± 0.85) than males (2.714 ± 1.021), while males had higher Consciousness (3.95 ± 0.909) and Perseverance (3.97 ± 0.917) than females. No significant gender differences were found in total willpower or Self-control.

3.3.2. Grade differences

One-way ANOVA with post-hoc comparisons found significant grade differences in total willpower and all dimensions ($p < 0.05$). Total willpower was highest in Secondary Vocational Year 1 (62.863 ± 9.775) and lowest in Secondary Vocational Year 3 (57.286 ± 6.061). Self-control was highest in Secondary Vocational Year 1 (1.757 ± 0.602) and lowest in College Year 2 (1.435 ± 0.555). Consciousness was highest in College Year 2 (4.114 ± 0.768) and lowest in Secondary Vocational Year 3 (3.709 ± 0.701). Decisiveness was highest in Secondary Vocational Year 1 (3.03 ± 0.799) and lowest in College Year 2 (2.415 ± 1.078). Perseverance was highest in College Year 2 (3.988 ± 0.989) and lowest in Secondary Vocational Year 3 (3.482 ± 0.854).

3.3.3. Student role differences

One-way ANOVA found significant differences in total willpower and the Consciousness factor based on student role. Student cadres had a significantly higher total willpower score (61.393 ± 9.166) than other categories. League members had significantly higher Consciousness (4.002 ± 0.66) than other categories.

3.3.4. Major differences

One-way ANOVA found significant differences in total willpower and the Consciousness factor based on major. Stomatology majors had a significantly higher total willpower score (63.234 ± 9.159) than other majors. Nursing majors had significantly higher Consciousness (3.883 ± 0.719) than other majors.

3.3.5. Parenting style

One-way ANOVA found that parenting style had a significant impact on the total willpower score and all four factors. Students with a democratic parenting style had significantly higher total willpower (61.131 ± 8.715), Perseverance (3.819 ± 0.826), and Consciousness (3.876 ± 0.704) than those with other parenting styles.

3.3.6. Parental relationship

One-way ANOVA found that the parental relationship had a significant impact on the total willpower score and all four factors. Students with a harmonious parental relationship had significantly higher total willpower (61.305 ± 8.817), Perseverance (3.853 ± 0.838), Decisiveness (2.835 ± 0.887), and Consciousness (3.893 ± 0.727) than those with other relationship types.

3.3.7. Multivariate analysis of variance (MANOVA) on willpower

A MANOVA with student gender, role, grade, major, parenting style, and parental relationship as independent variables and total willpower as the dependent variable showed that all factors except major had a significant influence on student willpower ($p < 0.01$).

3.3.8. Multiple regression analysis on willpower

A stepwise regression analysis with the same predictors (**Table 2**) showed that a harmonious parental relationship, being in Secondary Vocational Year 1, being in Secondary Vocational Year 2, and majoring in Stomatology were significant positive predictors of student willpower, jointly explaining 10.1% of the variance (Adj. $R^2 = 0.101$, $F = 24.239^{**}$). Secondary Vocational Year 1 contributed the most ($Beta = 0.20$), followed by a harmonious parental relationship ($Beta = 0.192$). Permissive and indulgent parenting styles, and not holding any student role, were significant negative predictors. Gender and grade (as a block) did not show significant predictive effects.

Table 2. Regression analysis of factors influencing willpower in secondary vocational students

| Predictor | Unstandardized coefficients | | Standardized coefficient(beta) | t-value | p-value | Adjusted R^2 | F |
|----------------------------------|-----------------------------|------------|--------------------------------|---------|----------|----------------|-------------------|
| | B | Std. Error | | | | | |
| Constant | 55.52 | 0.716 | 0 | | | | |
| Harmonious Parental Relationship | 4.901 | 0.662 | 0.192 | 77.544 | 0.000*** | 0.101 | $F = 24.239$, |
| Secondary Vocational Year 1 | 3.973 | 0.560 | 0.200 | 7.407 | 0.000*** | | $p = 0.000^{***}$ |
| Secondary Vocational Year 2 | 1.816 | 0.527 | 0.096 | 7.095 | 0.000*** | | |
| Parenting Style_Permissive | -5.141 | 1.485 | -0.089 | 3.447 | 0.001*** | | |
| Student Role_Holds no positions | -1.454 | 0.464 | -0.080 | -3.463 | 0.001*** | | |
| Major_Stomatology | 2.300 | 0.995 | 0.058 | -3.136 | 0.002*** | | |
| Parenting Style_Indulgent | -4.274 | 1.866 | -0.058 | 2.312 | 0.021* | | |

4. Discussion

4.1. The influence of student individual factors on willpower

4.1.1. Gender factors

This study found females had higher Decisiveness, while males had higher Consciousness and Perseverance. This aligns with existing domestic research [7]. Cross-cultural analysis by Costa et al. also found that in most global cultures, females score significantly higher on “Neuroticism” and “Agreeableness,” while males typically score slightly higher or similar on “Conscientiousness” [8,9]. This may be related to gender role socialization, where females are often encouraged to develop decision-making and self-expression, leading to stronger decisiveness, while males are expected to possess self-discipline and perseverance.

4.1.2. Grade factors

Analysis showed the highest total willpower in Secondary Vocational Year 1, with varying levels across dimensions in other grades. This is likely related to the academic stage, stressors, and psychological adaptation. First-year students have high enthusiasm and motivation. Second-year students face increased course pressure, challenging decisiveness. Third-year students face enrollment pressure/employment pressure, depleting psychological resources and reducing willpower. College Year 2 students have clearer professional direction and improved self-control but the lowest decisiveness, possibly due to complex decisions or plateau-phase anxiety.

4.1.3. Student cadre role factor

Students holding cadre positions exhibited stronger willpower, consistent with existing research ^[10]. This could be because students who become cadres inherently possess stronger willpower, and the role itself, involving handling affairs, coordinating conflicts, and persisting in plans, directly trains dimensions like Consciousness, Perseverance, and Decisiveness.

4.2. The influence of family factors on student willpower

4.2.1. Family parenting style factor

Students with a democratic parenting style performed significantly better in total willpower, Perseverance, and Consciousness, consistent with many studies ^[11]. When parents provide tolerance, understanding, and encouragement, smooth parent-child communication and a harmonious relationship are established. Children's negative emotions are alleviated in this atmosphere, collectively promoting willpower development.

4.2.2. Parental relationship factor

Students with a harmonious parental relationship significantly outperformed others in total willpower, Perseverance, Decisiveness, and Consciousness. Research by Wang Juan et al. also confirmed that parental conflict is a significant risk factor affecting the psychological resilience of secondary vocational students, influencing willpower through emotional resources ^[12]. Liu Hongyun et al. found that parental conflict reduces adolescents' emotional security, leading to decreased self-control ^[13].

5. Educational recommendations

5.1. For students: Enhancing self-management abilities

Students should actively enhance their awareness of willpower. Firstly, build self-confidence and avoid negative emotions. Secondly, overcome inertia and cultivate resilience; maintain energy through regular routines, a healthy diet, and physical exercise, and make plans to complete tasks promptly. Finally, actions should have clear goals and feasible plans; focus intently during execution to cultivate active consciousness.

5.2. For schools: Improving classroom teaching and practical education quality

During daily teaching, help students discover their strengths, challenge irrational cognitions, seek external support, and acquire skills like emotion management and problem-solving ^[14]. Enhance students' self-efficacy and professional confidence, thereby improving self-management and career planning abilities ^[15]. Develop targeted plans for students with different willpower levels, using different strategies by specialized teachers. Also, pay attention to individual personality differences ^[16]; although there are many methods to cultivate willpower, not every method is suitable for everyone; it must be tailored to the individual.

5.3. For parents: Providing positive emotional support and value guidance

Parents should commit to nurturing the will quality of secondary vocational students. The primary step is to create a harmonious family atmosphere, providing ample security and emotional support. Assisting children in establishing meaningful career development goals is crucial; the establishment of values and a sense of responsibility can significantly enhance willpower. Parents should also foster children's independent abilities, creating opportunities for them to solve practical problems. The exercise of willpower begins with daily

trivialities, such as adhering to regular schedules and physical exercise; parents should assist children in developing good habits from minor details, shaping characteristics of earnest pragmatism and persistence.

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Research on the “Three-Dimensional Empowerment” Path of Innovation and Entrepreneurship Capabilities of Vocational Undergraduate Students from the Perspective of Integration of Production and Education

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Abstract: Under the strategic background of the country vigorously promoting the high-quality development of vocational education and deepening the integration of production and education, vocational undergraduate education, as a key link connecting higher education and industrial needs, is entrusted with the mission of cultivating high-quality, innovative and entrepreneurship-oriented talents. Against this background, how to explore effective paths for cultivating college students' innovation and entrepreneurship capabilities based on the integration of production and education has become an urgent issue for teachers and vocational undergraduate institutions. While expounding the necessity of cultivating innovation and entrepreneurship capabilities of vocational undergraduate students from the perspective of integration of production and education, this paper discusses the main problems and the “three-dimensional empowerment” path, providing a reference for teachers.

Keywords: Integration of production and education; Vocational undergraduate education; Innovation and entrepreneurship; Three-dimensional empowerment

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1. Introduction

With the continuous development of China's market economy, society's demand for high-quality, innovative and entrepreneurship-oriented talents is constantly rising. As an important training base for high-quality talents in China, vocational undergraduate education should also take on the responsibility of talent cultivation, especially exploring effective paths for cultivating students' innovation and entrepreneurship capabilities based on the integration of production and education ^[1]. However, it can be seen that from the perspective

of integration of production and education, the innovation and entrepreneurship education in vocational undergraduate institutions still faces problems such as imperfect curriculum systems and insufficient teaching staff, which directly affect the cultivation of students' innovation and entrepreneurship capabilities and their future employment and development. In this regard, it is necessary to explore multi-dimensional innovation and reform paths while identifying the existing problems, so as to comprehensively improve students' innovation and entrepreneurship capabilities and comprehensive quality, and cultivate more high-quality talents with professional skills and innovation and entrepreneurship capabilities for society ^[2].

2. Necessity of cultivating innovation and entrepreneurship capabilities of vocational undergraduate students from the perspective of integration of production and education

2.1. Adapt to economic transformation and promote regional economic development

At present, we have entered the digital era. The development of technologies such as big data and artificial intelligence has brought new momentum to industrial transformation and upgrading. Against this background, society's demand for innovation and entrepreneurship-oriented talents is also constantly rising ^[3]. The innovation and entrepreneurship education under the integration of production and education enables students of vocational undergraduate institutions to come into contact with more cutting-edge industry knowledge and master more useful practical skills during their studies, which directly improves their employment competitiveness and industry adaptability. At the same time, the cultivation of high-quality, innovation and entrepreneurship-oriented talents can also bring great vitality to social and economic construction, thereby driving the development of related industries, promoting the transformation and upgrading of related industries, and providing effective support for the development of the local economy.

2.2. Innovate teaching models and improve education and teaching quality

In the past talent cultivation process of vocational undergraduate education, there was mostly a problem of "valuing theory" or "valuing skills", which led to insufficient adaptability of talent cultivation, resulting in graduates being unable to adapt to their jobs or meet relevant standards after entering the workplace ^[4]. Under the background of integration of production and education, strengthening the cultivation of students' innovation and entrepreneurship capabilities can also promote the reform and innovation of the entire teaching model. On the one hand, this model can introduce enterprise resources, and provide students with platforms for professional knowledge and skill learning, innovation and entrepreneurship capability improvement and development in combination with enterprise's real project cases and post work processes, which can also strengthen their industry cognition, improve their professional literacy, and lay a foundation for their subsequent employment and development; on the other hand, the development of the integration of production and education model can also promote the innovation and reform of teaching models and teaching staff in vocational undergraduate institutions, which is of great benefit to the improvement of education and teaching quality, as well as the cultivation of students' innovation and entrepreneurship capabilities and their future employment and development.

2.3. Inject innovation and entrepreneurship vitality and enhance enterprises' market competitiveness

Faced with the current background of increasing quality requirements for market talent demand, the cultivation

of innovative talents has become an important goal of vocational undergraduate education^[5]. The innovation and entrepreneurship education based on the integration of production and education can not only cultivate students' professional literacy but also promote the cultivation of their innovation capabilities and entrepreneurial awareness, thereby transporting more personnel with innovation and entrepreneurship awareness to enterprises, bringing advanced development momentum and vitality to enterprises, and promoting the innovation and reform of enterprises. At the same time, under the integration of the production and education model, enterprises and vocational undergraduate institutions can achieve multi-dimensional cooperation in talent cultivation, which can also help enterprises obtain more outstanding talents, promote the upgrading of enterprise technologies and standards, reduce enterprises' talent recruitment costs, and improve the adaptability of talent cultivation. Therefore, from this perspective, the innovation and entrepreneurship capability education based on the integration of production and education can transport more outstanding talents for enterprises, enhance enterprises' market competitiveness, and lay a foundation for the high-quality development of enterprises^[6].

3. Main problems in cultivating innovation and entrepreneurship capabilities of vocational undergraduate students from the perspective of integration of production and education

3.1. Imperfect school-enterprise collaborative education mechanism and lack of practical resources

Under the background of integration of production and education, the cultivation of innovation and entrepreneurship capabilities of vocational undergraduate students is directly affected by the imperfect collaborative education mechanism. On the one hand, enterprises' participation in innovation and entrepreneurship education needs to be improved. For example, some enterprises are unwilling to invest sufficient financial and human resources in innovation and entrepreneurship education, nor arrange appropriate practical positions for students, which leads to the disconnection of integration of production and education in the process of talent cultivation; on the other hand, some enterprises have insufficient cognition and recognition of innovation and entrepreneurship education, believing that this education should be mainly undertaken by schools, thus lacking sufficient participation awareness^[7]. In addition, under the background of integration of production and education, the imperfect mechanism of school-enterprise cooperation is also relatively obvious. The cooperation between many enterprises and schools only stays on the surface, and there is no in-depth talent cultivation cooperation, which also affects the realization of the goals of innovation and entrepreneurship and high-quality talent cultivation.

3.2. Disconnection between innovation and entrepreneurship education and professional education, and fragmented content

The advancement of innovation and entrepreneurship education needs to rely on professional education to form a new system of "integration of professional education and innovation and entrepreneurship education," so as to ensure the quality of education and talent cultivation. However, combined with the actual situation, there is a disconnection between current professional education and innovation and entrepreneurship education in vocational undergraduate institutions, and the educational content is also fragmented, which affects students' growth and development^[8]. Firstly, in terms of curriculum setting, professional education and innovation and entrepreneurship education are often independent, and the integration of innovation and entrepreneurship

education into professional courses is not systematic enough, which makes the quality of innovation and entrepreneurship education unsatisfactory. Secondly, from the perspective of teaching content, the content of innovation and entrepreneurship education is fragmented, lacking professional cases and practical guidance, which leads to students being unable to learn real knowledge and skills. In addition, the teaching content is disconnected from the current market development situation and industry development trends, unable to meet the current market demand for high-quality, innovative and entrepreneurship-oriented talents, making it impossible for students to use the knowledge they have learned to solve problems after graduation.

3.3. Insufficient innovation capabilities of the “dual-qualified” teacher team and low guidance effectiveness

The construction of “dual-qualified” teachers is the key to improving the quality of vocational undergraduate education under the integration of production and education. However, the innovation and entrepreneurship quality and educational capabilities of the current “dual-qualified” teacher team in vocational undergraduate institutions need to be further improved. Although many teachers have certain practical experience, they lack an in-depth understanding of new industry trends, new employment standards, and new post-work processes, which leads to their inability to use the latest innovation and entrepreneurship education concepts to educate students in practical work, affecting students’ growth and development^[9]. At the same time, some teachers lack professionalism in innovation and entrepreneurship education capabilities, and the school has not carried out corresponding education and training for this situation, which also affects the effective advancement of innovation and entrepreneurship education. In addition, some teachers use single methods and models in the process of promoting innovation and entrepreneurship education, lacking the application of diverse and modern models and means, which also largely affects the high-quality advancement of innovation and entrepreneurship education under the integration of production and education.

4. “Three-Dimensional Empowerment” path of innovation and entrepreneurship capabilities of vocational undergraduate students from the perspective of integration of production and education

4.1. Deepen school-enterprise cooperation and build a new collaborative education mechanism

Under the background of integration of production and education, the advancement of innovation and entrepreneurship education must first consolidate school-enterprise cooperation and build a collaborative new education platform to provide support for the cultivation of students’ innovation and entrepreneurship capabilities. In this regard, vocational undergraduate institutions should strengthen consultation and cooperation with enterprises to jointly formulate training plans for high-quality, innovation, and entrepreneurship-oriented talents^[10]. For example, professional teachers from the school can go deep into enterprises to understand the new standards of enterprise talent demand and new steps of post-work processes, and jointly formulate talent training plans with enterprise experts to ensure that the cultivation of students’ innovation and entrepreneurship capabilities is in the same direction as enterprise talent demand.

Secondly, in terms of curriculum design, the proportion of innovation and entrepreneurship-based courses should be increased based on real enterprise post-work^[11]. For example, schools can cooperate with enterprises to jointly develop innovative project cases based on practice, guiding students to carry out professional

innovative project practice, so as to cultivate their professional and technical capabilities and innovative literacy. Furthermore, both schools and enterprises should make full use of their respective resource advantages to accelerate the construction of practical bases and provide high-quality platforms for students' professional practice and innovation, and entrepreneurship practice.

In this process, real enterprise projects can also be introduced, and school teachers and enterprise mentors can jointly provide practical education and guidance for students to promote the cultivation of their comprehensive professional capabilities and innovation and entrepreneurship capabilities. For example, manufacturing majors can cooperate with local manufacturing enterprises to jointly build training bases, allowing students to carry out mechanical manufacturing production, inspection and maintenance, and other project work in the bases, to strengthen their post-work cognition and provide effective support for the cultivation of their innovation and entrepreneurship capabilities^[12].

In addition, both schools and enterprises should accelerate the establishment of a scientific enterprise internship mentor system, such as selecting outstanding enterprise personnel to serve as vocational internship mentors, to provide professional one-on-one guidance for students, strengthen the effect of students' professional practice and innovation and entrepreneurship practice, and escort the improvement of their comprehensive quality and professional competitiveness.

4.2. Promote curriculum integration and build a systematic, innovative curriculum system

Faced with the problems of disconnection between innovation and entrepreneurship education and professional education and fragmented content in vocational colleges from the perspective of integration of production and education, vocational undergraduate institutions should further promote the integration of professional education and innovation and entrepreneurship education, strengthen the connection between professional courses and innovation and entrepreneurship education, and build a systematic curriculum system integrating professional education and innovation and entrepreneurship education.

Firstly, in terms of curriculum setting, based on their own professional conditions and market demand, actively set up interdisciplinary innovation and entrepreneurship curriculum systems to lay a foundation for the integration of professional education and innovation and entrepreneurship education^[13]. For example, for management majors, interdisciplinary innovation and entrepreneurship courses such as "Innovation Management and Entrepreneurship Practice" can be offered, jointly taught by teachers from management, marketing, financial management and other majors, so as to lay a foundation for students' learning and practice of integrating professional education and innovation and entrepreneurship education and promote the improvement and development of their comprehensive quality.

Secondly, it is necessary to further promote the integration of professional education and innovation and entrepreneurship education courses. That is, in the process of professional teaching, teachers should dig deep into the innovation and entrepreneurship education elements based on the teaching content, guiding students to carry out knowledge exploration and practice in innovation and entrepreneurship while learning professional knowledge, to promote the coordinated improvement of their professional capabilities and innovation and entrepreneurship capabilities. For example, relevant enterprise innovation and entrepreneurship cases can be introduced based on professional course teaching content, guiding students to analyze and discuss the cases, and cultivating their innovative awareness and entrepreneurial thinking. For another example, in the practical link, some innovative practice projects for post-work can be designed, guiding students to carry out innovation and

entrepreneurship practice using professional knowledge, thereby promoting the cultivation and development of their comprehensive quality.

Furthermore, it is necessary to actively integrate various resources to build a resource library for integrating professional education and innovation and entrepreneurship education, providing materials for the cultivation of students' innovation and entrepreneurship capabilities^[14]. For example, digital technology can be used to build an innovation and entrepreneurship education resource library, including teaching cases, teaching videos, and entrepreneurial projects, guiding students to independently select content for learning according to their own professional characteristics and interests. On this basis, students' learning situation can be tested through digital platforms, and students can be guided to interact and communicate with classmates, teachers, and enterprise personnel, thereby stimulating their learning interest, improving their learning quality, and leading the improvement and development of their innovation and entrepreneurship capabilities.

4.3. Strengthen teacher team construction and forge a “dual-qualified” innovation guidance team

Teachers are the foundation of education. In the process of promoting the cultivation of students' innovation and entrepreneurship capabilities under the integration of production and education, it is necessary to do a good job in the construction of the teaching team, build a high-quality “dual-qualified” innovation guidance team, and provide more professional educational services and guidance for students^[15].

Firstly, vocational undergraduate institutions should actively provide teachers with opportunities to practice in enterprises, enabling them to learn more new industry changes, trends, and standards, master enterprises' actual needs and work processes, to improve their ability to promote innovation and entrepreneurship education, introduce more practical knowledge and cases in the education process, and ensure the effect and quality of innovation and entrepreneurship education.

Secondly, enterprise personnel can be actively introduced to serve as part-time teachers, giving play to their advantages in practical education, enabling them to form complementary advantages with professional school teachers, and jointly guiding students to participate in innovation and entrepreneurship competitions and projects, to effectively improve students' innovation and entrepreneurship capabilities.

Furthermore, teachers and enterprise personnel can be organized to form teaching and research groups on innovation and entrepreneurship education under the integration of production and education, regularly exchanging and analyzing practical problems in the cultivation of students' innovation and entrepreneurship, and exploring scientific methods and schemes to promote innovation and entrepreneurship education. In addition, schools should actively connect with relevant experts to provide training services on innovation and entrepreneurship education for teachers, so as to broaden teachers' professional horizons and improve their innovation and entrepreneurship capabilities.

Finally, schools can also encourage teachers to participate in innovation and entrepreneurship competitions by themselves or with students, and promote the improvement of teachers' innovation and entrepreneurship education capabilities and comprehensive quality through the method of “learning through competitions.”

5. Conclusion

In summary, from the perspective of integration of production and education, the cultivation of students' innovation and entrepreneurship capabilities has become an important part of the talent cultivation work

of vocational undergraduate institutions. In this regard, we should deeply grasp the necessity and practical problems, and on this basis, continuously explore multi-dimensional reform and practice paths, comprehensively improve students' innovation and entrepreneurship capabilities and comprehensive quality, lay a foundation for their better employment and development, and at the same time transport more high-quality, innovation and entrepreneurship-oriented talents for society.

Disclosure statement

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Exploration of an Innovative Training Model for “Excellent Forensic Medicine Postgraduates” in The Context of Intelligent Medicine

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Abstract: The rapid development of computer science and artificial intelligence has brought both challenges and opportunities to the training of forensic medicine graduate students. Traditional training models suffer from issues such as an overemphasis on theory, insufficient practical training, and inadequate outcomes translation. Against this backdrop, this forward-looking educational reform project explores an innovative talent cultivation model for “excellence forensic practitioners” within the context of intelligent medicine. The project first investigates the current application of virtual simulation and artificial intelligence in forensic education, and then, drawing on the “excellence engineering” training model, designs a pilot model that incorporates these technologies into the entire training process. The core objective is to establish a framework for the “excellence forensic practitioner” cultivation model, combining theory and practice, research and application, while strengthening practical skills and outcomes translation, as well as reforming the evaluation mechanism. The aim is to explore new approaches and effective methods for training forensic medicine graduate students in China.

Keywords: Forensic Science, Intelligent Medicine, Excellence Forensic Scientist, Talent Cultivation, Innovative Teaching Theory

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1. Challenges and intelligent pathways in the cultivation of excellence in forensic medicine talent

Forensic medicine serves as a crucial bridge between medicine and law, playing an irreplaceable role in upholding judicial fairness and establishing the foundations of social equity and justice ^[1]. As China enters a new era in the construction of a socialist rule of law, the reforms in the litigation system centered on trials have raised higher demands on the quality of evidence. Consequently, the scientific validity and authority of forensic expert opinions are undergoing unprecedented scrutiny. This profound transformation directly challenges the professional competence and practical abilities of forensic evaluators, thereby necessitating innovative reforms

in higher education, which bears the responsibility of cultivating talent in this field ^[2].

Although the forensic medicine education system in China has become increasingly refined, the graduate training process still faces multiple challenges, making it difficult to fully meet the new demands of rule of law development ^[3]. First, there is a significant disconnect between theoretical teaching and practical application. The traditional model places excessive emphasis on the delivery of theoretical knowledge, and graduate students have limited opportunities to engage with real cases or participate in complete forensic evaluations during their studies. This results in difficulties in translating acquired knowledge into the ability to solve complex real-world problems. Second, there is insufficient integration of cutting-edge technologies into education. Although the application of technologies such as virtual simulation and artificial intelligence in forensic medicine has yielded initial results ^[4], these efforts remain fragmented and have not been systematically incorporated into the entire graduate training process. Furthermore, there is a bias in the evaluation system, with current evaluations often focusing too heavily on the publication of academic papers while neglecting the assessment of students' practical skills in case analysis, technological innovation, and the translation of research outcomes. These challenges collectively hinder the development of high-quality, interdisciplinary "excellence forensic practitioners" and underscore the urgency for reform in the training model.

Currently, the wave of intelligent technologies represented by virtual simulation and artificial intelligence provides a historic opportunity to bridge the gap and reshape the forensic medicine education ecosystem ^[5]. In recent years, artificial intelligence (AI) technology has developed rapidly, and many scholars both domestically and internationally have begun exploring the application of AI in fields such as forensic pathology, forensic evidence, forensic anthropology, forensic clinical medicine, forensic toxicology, and forensic psychiatry ^[6]. Breakthroughs have been achieved in areas such as PMI (postmortem interval) estimation, individual identification, DNA profiling, diatom testing, injury recognition, toxicology testing, and the diagnosis and prevention of violent behavior in mental disorders, with some results already being applied and demonstrating superior model performance ^[7]. These technological applications not only effectively overcome the challenges of limited practical resources and the difficulty of replicating high-risk scenarios in traditional teaching but also systematically enhance students' practical skills and professional decision-making abilities through human-computer collaborative intelligent training models, providing crucial support for the reform of forensic medicine education. In the future, mastering artificial intelligence technology will be indispensable for cultivating excellence in forensic talent. To avoid being left behind by technological advancements, students must become both masters and users of these technologies ^[8]. Therefore, in the graduate training process for forensic medicine, it is essential to keep pace with the evolving demands of the era by incorporating AI technologies such as machine learning, deep learning, digital image processing, pattern recognition, and artificial neural networks into the curriculum. By imparting relevant knowledge, this approach will advance forensic medicine graduate students' progress in research, innovation, and solving traditional forensic challenges such as complex cause-of-death analysis, time-of-death estimation, individual identification, pattern analysis, and toxicological testing. This study emerged in response to the demands of the current era and aims to systematically explore and construct a future-oriented, innovative training model for "excellence forensic practitioners" under the domain of intelligent medicine.

2. Constructing a new paradigm for the cultivation of "excellence forensic practitioners"

This study aims to bridge the gap between theory and application, as well as research and practice, by

restructuring the curriculum, innovating practical pathways, and reforming the evaluation mechanism. The goal is to enhance students' practical skills and innovative competencies systematically, while establishing a replicable and scalable training model that provides new pathways and practical examples for cultivating high-end forensic talent in China, thereby contributing to the development of forensic medicine education.

The formation of this new paradigm is not a result of arbitrary design, but rather stems from a profound insight into existing challenges and a creative transformation of successful experiences. Its construction path is clear and specific:

2.1. Foundation of the new paradigm: Problem-driven approach and experience transfer

The construction of the new paradigm begins with two solid foundations: First, a thorough analysis of the existing challenges. We have recognized that the core contradiction in traditional training models lies in the disconnection between “academic training” and “professional competence.” While graduate students may excel in writing academic papers, they often lack the adaptability needed to tackle complex and unconventional forensic tasks ^[9]. This underscores that the starting point of the reform must be practice. Second, the beneficial transfer of successful models. The “Excellence Engineer” program has provided significant conceptual references and methodological insights for the reform of forensic medicine graduate education. The core value of this program lies in its breaking of traditional disciplinary boundaries and establishing a training paradigm focused on “industry needs” and “strengthening practical engineering skills.” By systematically integrating cutting-edge industry technologies and methods into the entire teaching process, it has created an evaluation system centered on solving complex engineering problems. This successful experience directly addresses the structural contradictions in current forensic medicine education, such as the disconnect between theoretical teaching and practical demands, as well as the insufficient technological empowerment.

2.2 Core solution of the new paradigm: Constructing a progressive training system of “human-computer collaboration and virtual-real integration”

Based on the aforementioned understanding, our proposed solution focuses on bridging the gap between “learning” and “application,” with the core concepts of “intelligent empowerment” and “competency-driven approach.” The reform is integrated across three dimensions: curriculum structure, practical pathways, and evaluation mechanisms, aiming to create a cohesive and interconnected new paradigm for the cultivation of “Excellence Forensic Practitioners.”

2.2.1. Curriculum restructuring: Embedding the “intelligent forensic medicine” gene

In traditional curricula, courses on intelligent technologies and forensic medicine are often disconnected, making it difficult for students to effectively apply new technologies within their professional field ^[10]. To address this, we have broken away from the conventional course structure, not simply by adding introductory courses on “Artificial Intelligence,” but by embedding the “gene” of intelligent technologies deeply into the core forensic medicine courses, thereby restructuring the knowledge framework. For example, in the course “Forensic Pathology,” we have introduced a module on the “Deep Learning-Based Death Time Inference Model,” guiding students not only to understand traditional morphological inference methods but also to learn how to use convolutional neural networks to process large volumes of histological image data, thereby comprehending the principles, advantages, and limitations of model construction. In the course “Forensic Biology,” we incorporated

a case study on “AI-Assisted Complex DNA Kinship Analysis,” where students can experience firsthand how big data algorithms solve kinship identification challenges in complex scenarios such as child trafficking and disaster victim identification, which traditional methods struggle to address ^[11]. This curriculum restructuring aims to cultivate graduate students with an integrated “Forensic Medicine-AI” mindset, enabling them to consciously apply intelligent technologies to solve cutting-edge scientific problems in the field.

The curriculum restructuring has laid a solid “Forensic Medicine-AI” knowledge foundation for students. However, to transform this knowledge into the ability to solve real-world problems, it is essential to implement a systematic, practical training phase that facilitates the critical leap from theoretical understanding to practical skills.

2.2.2. Shift in training model: Constructing an “intelligent-augmented” forensic practical skills ladder

(1) Human-Computer Collaboration in Developing Diagnostic Thinking

In the practical training phase, the project innovatively integrates intelligent analytical methods, guiding students to apply cutting-edge technological tools to handle real-case data. A progressive “human-computer collaboration” training paradigm has been established. In forensic pathology and clinical training, students are required to operate intelligent analysis systems, inputting complete autopsy data from sudden death cases or clinical data from injured individuals to generate death cause inferences or disability level assessments based on big data. However, the core design of this project goes beyond the mere application of technology and aims to foster a critical human-computer collaborative diagnostic mindset. Students are encouraged to question, validate, and ultimately integrate AI outputs: they must combine professional knowledge to thoroughly analyze the validity and limitations of intelligent suggestions, understand the boundaries and uncertainties of the algorithms. This repetitive process of “questioning - validating - building” enables students to solidify the scientific understanding that technology should assist, not replace, human judgment, thereby shaping their cautious verification and scientific decision-making abilities, which are essential in the age of intelligent technologies ^[6].

(2) Virtual Simulation Training

To achieve a risk-free transition from theory to practice, this project systematically designs a training module based on virtual simulation technology. We comprehensively integrate existing digital resources, such as 3D modeling, human-computer interaction, and case databases ^[12], to create highly realistic forensic work scenarios for students. In this environment, students are required to follow standard operating procedures and independently complete the full workflow, from the three-dimensional examination of the crime scene, trace evidence identification and collection, laboratory analysis, to the final formation of forensic conclusions. The core objective of this systematic training is to go beyond single-skill operations, thoroughly honing students’ abilities in constructing evidence chain logic, making comprehensive decisions in complex situations, and fostering awareness of standardized practices. During the training process, we introduce structured assessment metrics to provide real-time feedback and debriefing on students’ operational paths, evidence handling logic, and the rationality of their forensic conclusions, helping them identify potential gaps in professional judgment. Moreover, we simulate various complex situational variables, such as contradictory evidence, time pressure for forensic analysis, or case background interference, to guide students in

adjusting their strategies and responding flexibly to the uncertainties encountered in real forensic work. This highly immersive, repeatable, and error-tolerant training model effectively promotes the deep internalization of professional knowledge and skills, significantly shortening the cycle from knowledge acquisition to the development of professional competence^[13].

(3) Real Case Practical Training

The ultimate goal of virtual simulation is to serve real-world scenarios. After completing the systematic virtual training, students will enter collaborative forensic institutions, where, under the guidance of experienced forensic experts, they will participate in handling real cases. This phase is not only an application of skills but also a process of shaping professional identity and a sense of responsibility. Students are no longer merely learners; as members of the forensic team, they are tasked with specific forensic duties, and their analytical results will directly enter the judicial process.

2.2.3. Reform of the training evaluation mechanism: Implementing a “practice empowerment and multi-dimensional verification” result evaluation system

To fundamentally change the singular evaluation tendency of “publication-oriented” assessment, this project establishes a multi-dimensional, comprehensive evaluation system centered on “competency output^[14].” This system spans the entire training process and covers various dimensions, including knowledge integration, technical application, and innovative practice. In terms of process evaluation, we have designed a “Training Ability Portfolio,” which thoroughly records students’ performance in both virtual simulation and real case investigations. Key indicators, such as the completeness of the evidence chain construction, proficiency in using intelligent tools, and the reliability of forensic conclusions, are meticulously documented. Additionally, an industry expert blind review mechanism is introduced to ensure the objectivity and professionalism of the evaluation. At the results evaluation level, students’ assessments follow a “choose one of three” model:

- (1) An academic paper presenting innovative insights in the field of forensic justice.
- (2) A high-level virtual case investigation report and defense, which must demonstrate the ability to conduct systematic analysis of complex cases and include a critical evaluation of AI-assisted diagnostic results.
- (3) A technology patent or software copyright applied to forensic practice, such as a self-developed image recognition algorithm or intelligent diagnostic model^[15], which must have a clear application scenario and practical value.

This reform has fundamentally reversed the previous evaluation bias, which emphasized theory over practice and outcomes over process, shifting the focus from “what is known” to “what can be done.” For instance, students who choose the virtual case report option must defend their work before a joint committee of experienced forensic experts, who will question them on forensic logic, technical approaches, and innovative points. Students who select patent achievements, on the other hand, are required to demonstrate how their inventions improve solutions and effectiveness in real forensic scenarios. This “competency-based” evaluation approach effectively guides graduate students to shift their focus from pursuing the quantity of academic papers to enhancing their practical abilities and innovative capabilities, ultimately aligning talent development with industry needs.

3. Conclusion

This study actively explores a new training paradigm of “intelligent empowerment and competency-oriented” in

the field of forensic medicine graduate education reform. Drawing on the concept of “excellence engineering” education, we have restructured the curriculum, established a progressive training system, and implemented a multi-dimensional evaluation mechanism. These efforts have led to the preliminary formation of a “forensic excellence” training pathway that integrates theory and practice, and combines research and application. This model effectively enhances graduate students’ practical response abilities in complex cases and their capability to translate research outcomes into practical applications, offering a viable solution to the traditional dilemma in forensic medicine education, which tends to prioritize theory over practice. Looking ahead, we will continue to refine this training system and expect it to make a positive contribution to the overall improvement of high-end talent cultivation in forensic medicine, thereby providing stronger human resource support for the construction of a rule-of-law society in China.

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Research on The Cultivation and Dissemination of Chinese Cultural Awareness in College English Teaching

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Abstract: In college English teaching, cultivating and disseminating Chinese cultural awareness helps strengthen students' Chinese cultural genes and enhance the application value of English teaching. To achieve this educational goal, teachers should attach greater importance to the integration of Chinese culture into English teaching. Based on this, this paper briefly analyzes the value implication and current teaching situation of cultivating and disseminating Chinese cultural awareness in college English teaching, and discusses the strategies for the cultivation and dissemination of Chinese cultural awareness in college English teaching, aiming to cultivate more cross-cultural communication talents who can spread Chinese culture to the world.

Keywords: College English; Chinese cultural awareness; Cultivation and dissemination

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1. Introduction

Against the background of globalization, college English teaching is entrusted with the task of imparting language skills to students and the mission of transporting more English talents with good cross-cultural communication capabilities and Chinese cultural awareness for social development. Therefore, college English teaching urgently needs to integrate Chinese cultural elements to cultivate students' Chinese cultural awareness and communication capabilities. Only by deeply understanding and loving their own national culture can students confidently tell Chinese stories on the international stage and realize two-way cultural exchange.

2. Value implication of cultivating and disseminating Chinese cultural awareness in college English teaching

2.1. Strengthen students' Chinese cultural genes

Higher education is the main position for inheriting and promoting cultural values. Colleges and universities

should assume the responsibility of inheriting Chinese cultural genes and cultivating students' cultural confidence. As an important part of college education, English teaching has unique advantages in cultivating and disseminating Chinese cultural awareness. Through English learning, students can re-understand Chinese culture from a "cross-cultural" perspective. On the one hand, in English teaching, teachers guide students to interpret Chinese cultural elements in English, such as letting students think about the similarities and differences between the concept of "harmony" in China and the West, and reflect on the Chinese wisdom of "harmony in diversity", thereby deepening their cultural cognition of Chinese culture. On the other hand, with the acceleration of globalization, it is crucial to tell Chinese stories well on the international stage^[1]. Strengthening students' Chinese cultural awareness and communication capabilities in college teaching helps students inherit and promote Chinese culture with a more inclusive and open attitude, and promotes the exchange and mutual learning between Chinese culture and world culture.

2.2. Enhance the application value of English teaching

Traditional college English teaching emphasizes the imparting and learning of students' basic language skills such as listening, speaking, reading, and writing. Although students have good basic language skills, they ignore the cultural connotations behind the language. Strengthening the cultivation of students' Chinese cultural awareness and the improvement of their communication capabilities in college English teaching makes English teaching not only a "window" for students to understand Western countries but also a "microphone" to help students spread Chinese culture. For teaching objectives, integrating Chinese culture into English teaching makes the cultivation of students' cross-cultural communication capabilities more targeted, transforming into cultivating students' ability to interpret and express Chinese and Western cultures^[2]. Specifically, it requires students to use English to narrate the wisdom heritage of ancient China and the development achievements of contemporary China. In this process, students' comprehensive language skills and cultural identity will achieve a qualitative leap.

3. Current situation of the cultivation and dissemination of Chinese cultural awareness in college English teaching

3.1. Fragmented teaching content and relatively single carriers

Currently, the content related to Chinese culture in college English textbooks has shortcomings, including fragmentation and a relatively narrow range of carriers, which reduces the adaptability of cultivating and disseminating Chinese cultural awareness. Currently, college English textbooks involve little content about Chinese culture, most of which is presented in the form of "cultural tips" and "supplementary reading." The interpretation of Chinese cultural content is also superficial, making it difficult for students to deeply understand and master it^[3]. In addition, the integration of Chinese culture into college English teaching is mainly carried out through forms such as Chinese-English translation and reading comprehension, lacking digital and interactive carriers. For example, when introducing content related to Peking Opera facial masks to students, teachers mainly use official promotional videos for foreign audiences, and students focus on Chinese-English translation rather than interactive forms, such as letting students preview before class and explaining Peking Opera facial masks in English during class. The single teaching carrier can neither stimulate students' interest in learning the English communication of Chinese culture nor cultivate their practical ability to "spread Chinese culture in English."

3.2. Teachers' cultural literacy and teaching capabilities need to be strengthened

Most college English teachers have a good English professional background and teaching capabilities, but their knowledge system focuses more on the history, culture, literature and folk customs of English-speaking countries. They lack systematic cognition of traditional Chinese culture, and even some teachers can only express common Chinese cultural nouns and ancient poetry translations in English^[4]. For example, some teachers can proficiently explain Western cultural ideas in Shakespeare's plays to students in English, but it is difficult for them to accurately interpret the complex and diverse connotations of "benevolence" in "The Analects of Confucius" in English. This will lead to the cultivation of Chinese cultural awareness in college English teaching, becoming a "superfluous addition." In addition, some college English teachers have a certain level of Chinese cultural literacy, but they tend to turn the cultivation and dissemination of Chinese cultural awareness into "knowledge indoctrination," such as letting students rote-learn English words of traditional Chinese festivals without in-depth interpretation of the cultural connotations behind these festivals. Thus, students feel that learning Chinese culture in English courses is useless.

3.3. Lack of value orientation and monotonous forms in the evaluation system

The evaluation system of college English teaching usually "values skills over awareness," focusing on assessing students' English language knowledge and skills, and the assessment methods mainly examine students' listening, speaking, reading and writing abilities through test papers. The CET-4 and CET-6 exams involve some cross-cultural communication knowledge, mainly emphasizing students' mastery of Western culture, such as Western festivals, customs and social etiquette. Although the English expression of Chinese culture has been increasing year by year, the effect in cultivating students' Chinese cultural awareness and communication capabilities is not ideal. At the same time, this evaluation orientation tends to make teachers and students "score-oriented". Even if students take the initiative to learn English expressions and communication skills related to Chinese culture, it is only to obtain high scores^[5]. In addition, the content of Chinese culture in current college English assessment and evaluation mostly adopts question types such as multiple-choice questions and fill-in-the-blank questions. Students can often quickly fill in English words related to Chinese culture, but they cannot understand and spread Chinese culture in English. This evaluation system also cannot accurately measure students' Chinese cultural awareness and communication capabilities.

4. Analysis of strategies for the cultivation and dissemination of Chinese cultural awareness in college English teaching

4.1. Enrich Chinese cultural elements and resources in college English teaching

English textbooks are the main materials for students' English learning, containing a lot of knowledge and information, but lacking introductions to Chinese culture. Only when teachers scientifically grasp the connotation of Chinese cultural content in textbooks can they quickly find teaching elements with Chinese culture in them^[6]. For example, some textbooks introduce Qu Yuan's story through the different understandings of "dragon" in the West and China. Although such content is limited to certain themes and scopes, students can naturally absorb Chinese cultural knowledge through learning^[7]. Therefore, in the process of lesson preparation, teachers should thoroughly analyze the narration of Chinese customs, costumes, festivals, etiquette, and other aspects, and then integrate them into classroom teaching activities. College English textbooks usually integrate Chinese culture into independent unit themes, such as introducing the cultural heritage of various countries, and

even involving parts of ancient Chinese navigation when introducing the history of navigation and exploration of various countries. Therefore, when designing teaching activities, teachers should pay attention to which essential cultural elements to select for in-depth explanation when involving Chinese cultural content. In addition, current college English teachers adopt the attitude of “teaching what is available in textbooks” towards Chinese cultural teaching content. However, in terms of Chinese cultural content itself, the existing English teaching content cannot cover this need. Therefore, when teaching in class, the teaching content and structure of Chinese culture should be determined according to different purposes, objects and strategies. For example, when teaching English expressions related to Chinese culture, we can use English versions of major Chinese media such as China Daily and CGTN to explore teaching discourses in different thematic contexts, laying a good foundation for students to have a deeper understanding of Chinese culture and establish correct values.

4.2. Innovate teaching methods for integrating Chinese culture into college English teaching

Cultural awareness cultivation is a subtle and slow process rather than a way of applying what is learned. Therefore, teachers need to change teaching methods to adapt to this process. For example, adopt a comparative learning model to guide students to discover the thinking styles behind the similarities and differences between Chinese and Western cultures. For example, teachers create a teaching activity for students to “compare and reflect on the symbolic meanings of colors in China and the West,” allowing students to search for information online by themselves and write English speeches to express their insights and views on this topic, so as to strengthen their language conversion ability and deepen their cultural understanding^[8]. In addition, teachers can also adopt project-based learning methods, such as setting thematic tasks such as “Chinese cuisine conquers the world” and “modern inheritance of excellent traditional Chinese culture,” allowing students to internalize and absorb Chinese culture in the process of searching for information, formulating plans, and presenting in bilingual. Furthermore, teachers can use situational simulation to let students explain the connotation of Chinese culture in English in specific situations, so as to improve their ability to cope in different situations. However, when using the above teaching methods, teachers should change their understanding of their role positioning, from knowledge transmitters to learning guides, to maximize the effect and enable students to actively and comprehensively develop good Chinese cultural awareness and communication capabilities in English learning.

4.3. Construct a “China-West integration” training and development system for college English teachers

Colleges and universities should establish a “regular Chinese cultural literacy” training system for English teachers, incorporate Chinese cultural training into the professional development system of English teachers, and abandon the previous educational method of “valuing language over culture.” Firstly, offer special courses such as “Traditional Chinese Culture Seminar” and “Contemporary Development of Chinese Culture,” and invite literary scholars and historical scholars to give lectures to help teachers master the values inherited and upheld by the Chinese nation, including but not limited to Confucius’ “benevolence and etiquette,” Laozi’s “inaction,” and contemporary China’s “rural revitalization” and “strengthening the country through science and education,” thus forming a complete Chinese cultural knowledge system of “tradition + modernity”^[9].

Secondly, organize teachers to carry out “Chinese cultural investigation and practice”, such as visiting world natural heritage sites, such as Longji Terraces and South China Karst; conduct research in traditional

Chinese villages and high-tech parks, allowing teachers to deepen their understanding of Chinese culture through on-site experience, and then transform personal experience into teaching resources. In addition, colleges and universities should strengthen English teachers' ability to integrate culture and language through "special teaching and research + case demonstration." For example, cooperate with other local colleges and universities to carry out thematic teaching and research activities on "integrating Chinese culture into English teaching," allowing teachers to jointly discuss how to organically combine Chinese cultural content with English listening, reading, writing and speaking teaching. At the same time, actively carry out listening and evaluation activities, allowing teachers to learn from excellent teachers how to integrate Chinese culture into English classroom teaching through observation, so as to improve their teaching effect in cultivating students' Chinese cultural awareness and communication capabilities.

4.4. Improve the evaluation system for the cultivation and dissemination of Chinese cultural awareness in English teaching

To ensure better educational results in the cultivation and dissemination of Chinese cultural awareness in college English teaching, teachers need to improve the evaluation system for this goal. For example, add Chinese culture-related content to homework and final exams, such as including recent English reports from major Chinese media in the listening part; requiring students to analyze Chinese cultural phenomena such as "the modern changes of Spring Festival culture" and "the acceptance of traditional Chinese medicine overseas" in English in the writing part; adding impromptu speech sessions on Chinese cultural themes such as "Chinese cuisine" and "Chinese poetry" in the speaking part. At the same time, set corresponding evaluation criteria to assess students' depth of understanding, accuracy of interpretation, and effectiveness of communication of Chinese culture. In terms of the improvement of evaluation methods, innovative methods should be introduced both in form and final effect ^[10]. For example, introduce the cultural learning file recording method in formative evaluation, allowing students to record their understanding and creative expression of Chinese culture in English learning; introduce group cooperation tasks of making Chinese cultural short videos in summative evaluation, to exercise students' Chinese cultural awareness and communication capabilities while improving their teamwork and communication skills. Finally, in terms of evaluation subjects, in addition to traditional teacher evaluation, multiple subject evaluation models such as student self-evaluation, peer evaluation and expert comments should be introduced, so as to comprehensively present the training results and existing problems of students in various aspects such as Chinese cultural awareness, attitude and behavior, and provide feedback for the optimization of subsequent teaching strategies.

5. Conclusion

In summary, cultivating and disseminating Chinese cultural awareness in college English teaching is a long-term task. Teachers should change teaching concepts and innovate teaching models to cultivate students' good Chinese cultural awareness and communication capabilities. Strengthen the nourishment of Chinese cultural knowledge through various teaching approaches, improve students' internal Chinese cultural literacy and external cross-cultural communication capabilities, and inject new vitality into the national team of high-quality international communication talents.

Disclosure statement

The author declares no conflict of interest.

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Immersion and Resonance: Constructing an Embodied Cognition Teaching Model for Ideological Education Empowered by VR Technology

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Abstract: Driven by the digital revolution, virtual reality (VR) technology, as a cutting-edge innovation, is gradually reshaping the pedagogical landscape of ideological and political theory courses. Grounded in the theoretical framework of embodied cognition, this paper explores the construction of an intelligent educational ecosystem for VR-empowered ideological and political education, aiming to transcend the limitations of traditional “disembodied learning.” By analyzing the triadic interaction mechanism among “body–environment–cognition,” the study proposes a VR-based teaching model characterized by immersive experience and emotional resonance, termed the “embodied cognition” model for ideological and political courses. The operational logic of this model is elaborated across four dimensions: situational embodiment, experiential embodiment, interactive embodiment, and evaluative embodiment. Furthermore, the research critically examines potential risks associated with technological application, including subjectivity erosion, cognitive bias due to emotional overstimulation, and ethical dilemmas, while proposing corresponding countermeasures. This work aims to provide theoretical and practical insights for the innovation of ideological and political education in the digital era.

Keywords: VR technology; Ideological and political courses; Embodied cognition; Teaching model; Immersive experience

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1. Introduction

The rapid evolution of digital technologies is driving a profound paradigm shift in the teaching of ideological and political theory courses^[1]. Nevertheless, traditional pedagogical approaches remain constrained by the dual challenges of “one-way indoctrination” and “disembodied cognition,” overemphasizing abstract theoretical instruction while neglecting students’ bodily engagement, emotional experiences, and contextual interactions

that are central to cognitive construction. This form of “neck-up education” creates a significant disconnect with contemporary university students, who are “digital natives” accustomed to interactive, sensory-rich, and personalized modes of learning ^[2]. In addressing increasingly individualized and diversified student needs, conventional models of ideological and political education face core challenges such as insufficient precision, limited reach, and difficulties in measuring educational outcomes ^[3].

To address these issues, it becomes imperative to empower ideological and political courses through VR technology, striving toward holistic education throughout all processes, domains, and participants (“three fulls” principle). Moreover, the inherent characteristics of VR, immersion, interactivity, and imaginative capacity, align closely with the principles of embodied cognition, which emphasize “mind-body unity” and “cognition as bodily grounded.” Both paradigms reject Cartesian dualism and affirm that “the mind is the body’s mind, and cognition is bodily cognition” ^[4]. Situated at the intersection of embodied cognition theory and VR-enabled pedagogy, this study focuses on two core features, immersion and resonance, to transcend the cognitive boundaries of traditional ideological and political education. It seeks to facilitate a transformative journey from passive knowledge reception to active value internalization, thereby contributing to the theoretical and practical innovation of ideological and political education in the digital age.

2. Theoretical foundation: The fusion logic of embodied cognition and VR technology

Embodied cognition emerged in the 1980s at the intersection of phenomenological philosophy and cognitive science, evolving into a pivotal perspective within cognitive studies. It represents a post-cognitivist turn following symbolic information processing and connectionist models, offering a new interpretation of how humans acquire knowledge ^[5]. The integration of embodied cognition with VR technology is not merely a technical addition but constitutes a deep restructuring of educational paradigms, one rooted in robust philosophical and scientific foundations, possessing strong theoretical coherence and pedagogical compatibility.

2.1. Philosophical and cognitive science foundations

Originating from the convergence of phenomenology and cognitive science, embodied cognition challenges the classical cognitivist view that treats the mind as an abstract symbol processor operating independently of the body, “disembodied cognition.” Instead, it posits that cognition arises from the dynamic interplay between bodily perception, motor systems, and environmental interaction. As Maurice Merleau-Ponty stated: “The body is the medium through which a being exists in the world; to have a body means to be engaged in a specific environment, involved in certain projects, and continually situated within it” ^[6]. Within the context of ideological and political education, this implies that students’ understanding and internalization of values and beliefs cannot occur in isolation from bodily sensation and experiential activity.

This theoretical premise resonates naturally with the affordances of VR technology. By delivering multisensory stimuli, enabling natural interaction, and reconstructing historical or moral scenarios, VR creates digital conditions conducive to bodily participation in cognitive formation. Thus, VR facilitates the reintegration of body and cognition within simulated environments, transforming abstract ideological concepts into perceptible, lived experiences.

2.2. Pedagogical compatibility analysis

Cognition is not a priori a logical faculty but a situated, evolutionary process shaped by context. Environment, therefore, serves as a prerequisite for cognition^[7]. The fusion of VR technology with ideological and political education establishes a bidirectional human-technology interaction, fostering an organic learning ecosystem. Contemporary college students, as “digital natives,” exhibit cognitive preferences marked by sensory orientation, visual literacy, and demand for interactivity. Traditional lecture-based instruction, centered on textual exposition, often fails to meet these emerging cognitive expectations.

VR-supported embodied learning environments represent a proactive response to this shift, a deliberate adaptation to digitally mediated educational contexts. From the standpoint of ideological and political education itself, its ultimate goal lies in facilitating the transition from intellectual comprehension to authentic value commitment. This transformation relies not only on rational understanding but also crucially on emotional arousal and contextual immersion as catalysts. Precisely because VR enables the synthesis of affective experience and rational reflection, it provides fertile ground for the emergence of genuine value identification.

2.3. Educational significance of VR in ideological education

In the domain of ideological and political education, the significance of VR extends beyond mere instructional tool innovation; it fundamentally reshapes the educational process. On one hand, VR opens novel pathways for experiential learning, expanding the scope of the “Great Ideological and Political Course” initiative into virtual practice spaces. On the other hand, it offers fresh solutions to the persistent problem of “knowledge-belief disconnection” (zhi xin fenli), where students may intellectually grasp ideals without emotionally embracing them. Through bodily engagement facilitated by VR, learners can achieve deeper internalization of values, making the critical leap from “knowing” to “believing.”

3. Intelligent ecosystem: Core framework of VR-enabled embodied cognition teaching

Building upon the integrative logic of embodied cognition and VR technology, this study constructs an intelligent, efficient, and positive learning ecosystem characterized by “immersion and resonance.” Within this ecosystem, human instructors and AI-driven systems collaborate synergistically, reflecting the emerging trend of “human-machine collaboration” as the future trajectory of teaching roles in the intelligent era. This collaborative framework gives rise to a four-dimensional embodied cognition teaching model: situational embodiment, experiential embodiment, interactive embodiment, and evaluative embodiment”^[8].

3.1. Situational embodiment: Spatiotemporal dialogue between history and reality

Situational embodiment forms the foundational layer of the VR-enhanced teaching model. Its essence lies in recreating authentic contexts, historical events, social realities, or moral dilemmas, through scene reconstruction and environmental immersion, thereby establishing a virtual space conducive to bodily engagement in cognitive processes^[9].

In this phase, VR transcends its role as a mere visual display tool, becoming a bridge connecting past and present, theory and emotion. Here, ideological and political educators co-create multidimensional temporal-spatial teaching contexts with VR-AI systems, ensuring organic alignment between virtual scenarios and pedagogical objectives. This demands that teachers transcend traditional boundaries of responsibility,

recognizing that digital literacy and digital survival capabilities have become essential dimensions of socio-personal development. Cultivating these competencies must be deeply integrated with mainstream value education, encompassing skills such as proficient use of digital tools, enhanced abilities in information filtering, analysis, and processing, as well as fostering interpersonal communication and collaboration in virtual spaces.

3.2. Experiential embodiment: Multisensory engagement and emotional resonance

Experiential embodiment constitutes the core of the teaching model, focusing on activating students' emotional responses via multimodal sensory channels to foster value internalization. This dimension draws directly from a central tenet of embodied cognition: affect, attitude, and values emerge through bodily perception and experience.

Multisensory immersion serves as the foundation of experiential embodiment. In VR practice, ideological and political educators should prioritize not only visual realism but also integrate auditory, haptic, and even olfactory feedback when feasible, thereby intensifying emotional immersion. Crucially, the mechanism of emotional resonance underpins this stage. To achieve this, the model incorporates a role-based task-driven approach, wherein students assume identities of historical figures (e.g., revolutionary soldiers, pioneers of reform), engaging in mission-oriented activities within reconstructed historical settings. Through role-playing, learners naturally develop empathetic identification with characters, forming affective bonds that deepen their moral and ideological understanding.

As such, VR enables the creation of “personalized, dynamic, and immersive educational scenarios,” profoundly activating the inherent function of ideological and political courses in cultivating virtue and shaping character^[10].

3.3. Interactive embodiment: Reconstructing subjectivity through praxis

Interactive embodiment represents the pivotal phase of the model, emphasizing intelligent interaction and active learner participation to reestablish students' subjectivity in ideological and political learning.

Intelligent interaction design provides the technical backbone. Advanced VR systems support gesture recognition, motion tracking, voice commands, and eye-tracking, empowering students to explore virtual environments autonomously. More importantly, subjectivity reconstruction is the central pedagogical aim. In traditional classrooms, students often function as passive recipients of knowledge; in contrast, within a VR-embodied learning environment, they become active agents, participants in action, constructors of meaning.

This shift aligns with broader goals of improving the quality and effectiveness of higher education ideological and political courses, promoting seamless integration between online and offline instruction, and achieving true internalization, entering the brain, touching the heart, and guiding behavior (“entering mind-heart-action”)^[11].

3.4. Evaluative embodiment: Precision assessment via behavioral analytics

Evaluative embodiment marks the innovative dimension of the model, leveraging behavioral data analytics and multidimensional assessment to achieve precise monitoring of students' learning trajectories.

Its novelty lies in shifting evaluation from singular knowledge tests to comprehensive assessments incorporating behavioral performance, emotional reactions, and cognitive outcomes. By doing so, it better reflects actual student conditions, supports practical teaching, strengthens the soul-shaping and virtue-nurturing

functions of ideological and political courses, makes classes more vibrant, engages students actively, and enhances educational efficacy ^[12].

VR systems can record real-time behavioral data, including gaze patterns, navigation paths, decision-making sequences, and interaction frequencies. These metrics offer objective indicators for assessing cognitive processing and affective states. Additionally, a multimodal evaluation system integrates behavioral data, emotional responses (e.g., via AI-powered facial expression or physiological signal analysis), and traditional cognitive outputs. In practice, combining AI emotion recognition with qualitative methods allows for a more holistic and nuanced assessment framework.

4. Critical reflection: Risks and transcendence in VR embodied models

The application of VR technology is never a value-neutral instrumental process. It inherently requires ideological and political educators to undergo profound role transformation and identity redefinition. The key does not lie solely in mastering the technology, but in maintaining a value anchor centered on humanistic orientation amidst the tide of technological advancement; this must remain the fundamental principle guiding educational practice.

4.1. Technological dependence and subjectivity dissolution

In embodied pedagogy, bodily action constitutes its phenomenological manifestation, while ethical awareness serves as its underlying rational core, both jointly shaping complete cognitive and value internalization. While VR enhances course engagement, it simultaneously raises concerns about technological dependence and the erosion of learner agency.

As German educator Johann Friedrich Herbart insightfully noted: “All educational work and the entirety of education can be summed up in the concept of morality; morality is humanity’s highest purpose, and thus the highest aim of education” ^[13]. This observation reveals a fundamental tension in VR-based ideological education: the paradox between technological enhancement and subjective diminishment. When visual spectacle dominates instruction, students’ attention may shift from ideological depth to sensory stimulation, potentially undermining critical thinking. Moreover, in an age of pluralistic knowledge and heightened individual autonomy, the mission of “cultivating virtue” and “nurturing morally grounded individuals” becomes ever more urgent ^[14].

To transcend this risk, the principle of “technology serving content” must be upheld. Educators must clearly recognize VR as a means rather than an end, avoiding technological spectacle at the expense of educational integrity. Furthermore, VR scenario designs should incorporate sufficient space for exploration, reflection, and creative input, safeguarding students’ agency and creativity within virtual environments.

4.2. Emotional resonance and cognitive bias

Another potential pitfall lies in the contradiction between emotional resonance and cognitive distortion. While VR effectively stimulates emotional responses, excessive emotionalization may suppress rational deliberation, leading to oversimplified interpretations of complex historical or social realities.

In highly emotive VR experiences, students may become absorbed in affective immersion while neglecting deeper inquiry into historical context or theoretical nuance. A more profound concern involves the

epistemological gap between virtual simulation and real-world practice, which may generate cognitive biases. As Ye Lan argues: “Although modern technologies like computers have taken over some of teachers’ tasks, the essence of schooling remains unchanged. Education is a profoundly human endeavor. The relationship between teacher and student should be an ‘I-Thou’ relationship, centered on dialogue and mutual understanding”^[15].

To address this challenge, a complete pedagogical cycle of “experience–reflection–action” must be established. After VR immersion, instructors should guide students in critical reflection, helping them discern differences between simulated scenes and historical totality, and appreciate the complexity behind historical choices. Furthermore, linking virtual experiences with real-life social practice, such as community service, field visits, or policy debates, can help students achieve a balanced and accurate grasp of ideological theories.

4.3. Ethical dilemmas and data privacy

The widespread adoption of VR in ideological and political education also confronts serious ethical and privacy challenges. Addressing these issues is vital not only for pedagogical effectiveness but also for educational equity and technological ethics.

Physical discomfort is a common side effect of VR usage. Some students may experience dizziness, nausea, or eye strain during prolonged exposure, negatively impacting both learning experience and attitudes toward the course. To mitigate this, educators should accommodate individual differences by offering flexible participation options, such as shortening session durations or providing non-VR alternatives, ensuring inclusive access for all learners.

Data privacy presents another critical concern. Sensitive information collected by VR systems, including behavioral logs, gaze tracking, and biometric signals (e.g., heart rate, if mishandled or inadequately protected, could violate student privacy. Institutions must therefore establish stringent data governance policies, clearly defining the scope, purpose, and limits of data collection and usage, ensuring full compliance with privacy protection standards and informed consent protocols.

5. Conclusion

By creating multisensory, immersive virtual environments, VR technology offers an ideal pathway for realizing embodied cognition in ideological and political education. It effectively promotes a pedagogical transformation from disembodied learning to embodied cognition, and from knowledge acquisition to value internalization. However, the sustainable development of VR-enhanced ideological education must remain vigilant against risks such as technological dependency, subjectivity erosion, and emotional-cognitive imbalance.

The guiding principle must always be “technology serving educational content,” ensuring that VR functions as a genuine empowering tool rather than a distracting spectacle. In the digital era, the deep integration of VR technology with ideological and political courses has become an inevitable trend in educational innovation. Only by adhering to the core principles of human-centered design, technological empowerment, and unity of knowledge and action can the unique advantages of VR in ideological and political education be harnessed and cultivate a new generation of youth capable of shouldering the great mission of national rejuvenation.

Disclosure statement

The author declares no conflict of interest.

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Research on Cultural Identity and Development Strategies of English Majors in the New Era

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Abstract: The core goal of English teaching is to cultivate comprehensive and applied talents with solid English language foundation, strong language application ability, as well as certain humanistic and social science literacy, critical thinking ability, innovation ability and self-development ability. The core approach to achieving this teaching goal lies in strengthening students' cultural identity. With the rapid development of science and technology, globalization has become an irresistible trend of the times. Through advanced information technology and developed mass media, different cultures around the world are accelerating exchanges and integration, placing us in a complex multicultural environment. Taking cultural identity as the research entry point, this paper, based on a practical problem-oriented perspective, explores students' cognitive understanding and value orientation towards their mother tongue, target language, and their surface and deep cultures, and then proposes targeted development strategies. It aims to help English majors form rational cognition and value judgment of the two types of cultures, and promote the optimization and improvement of English education quality.

Keywords: Cultural identity; Target language culture; Native culture; Development strategies

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1. Problem statement

English learning is by no means merely the acquisition of language skills, but also involves the understanding and cognition of related cultures. Language and culture are inherently inseparable, there is no language that exists independently of culture, and the use of language is always influenced and restricted by culture. For this reason, the important value of cultural identity for foreign language learning has attracted increasing attention. This paper mainly addresses the following three issues:

- (1) The current situation of foreign language learning in a multicultural context: How to objectively understand the impact of English learning on the cultural identity of English majors from the perspective of the relationship between language and culture.
- (2) The era demand for enhancing national cultural soft power: Giving full play to the educational function

of university culture, guiding English majors to consciously inherit and carry forward excellent traditional Chinese culture, and helping students effectively and correctly learn from the essence of Western culture are not only important measures to enhance national cultural soft power but also an inevitable requirement of the times.

- (3) The cultivation of core values of contemporary English majors: Exploring effective strategies to enhance English majors' identification with excellent traditional Chinese culture, further deepening their cognitive depth and breadth of traditional Chinese culture, and enabling them to enhance their humanistic literacy, national sense of responsibility and socialist core values under the influence of excellent Chinese culture have very important contemporary significance and far-reaching impact ^[1-4].

2. Investigation and discussion on the current situation of cultural identity of undergraduates in Shiyuan College of Nanning Normal University

2.1. Research objects

The research objects are 132 English major undergraduates from Shiyuan College of Nanning Normal University. A total of 132 questionnaires were distributed and 132 valid ones were collected, including 46 freshmen, 43 sophomores, and 43 juniors. The gender distribution of the sample is 11.4% male and 88.6% female; 47.8% of the samples are from urban areas and 52.2% from rural areas.

2.2. Research methods

This study mainly investigates the current situation of college students' cultural identity, adopting two methods: questionnaires and interviews ^[5-7].

2.3. Questionnaire Survey

2.3.1. Language and cultural identity

Table 1. Statistical data on language and cultural identity (%)

| Items | Strongly Agree | Agree | Not Sure | Disagree | Strongly Disagree |
|---|----------------|-------|----------|----------|-------------------|
| I hope to learn English expressions of Chinese culture to promote English learning | 50% | 20% | 8% | 15% | 7% |
| It is necessary to introduce Chinese culture to foreigners when communicating with them | 58% | 26% | 10% | 6% | 0% |
| English teachers should increase the proportion of explanations on cultural background knowledge related to China and English-speaking countries | 56% | 43% | 0% | 1% | 0% |
| To learn English, one only needs to study the target language culture, and there is no need to invest energy in learning Chinese culture | 0% | 15% | 0% | 45% | 40% |
| Amid the current upsurge in foreign language learning, some people advocate paying more attention to the study of Chinese and excellent traditional Chinese culture | 20% | 55% | 5% | 14% | 6% |

From the survey data on language and culture (**Table 1**), it can be found that the vast majority of students hold a positive attitude towards the role of Chinese culture and English-speaking countries' culture in English

teaching. They expect teachers to increase the proportion of explanations on these two types of cultures in English classes, believing it is necessary to improve their ability to express Chinese culture in English to spread Chinese culture to foreigners, and also hope to further understand the relevant cultural knowledge of English-speaking countries. Only a few students have vague cognition or believe that culture does not have a positive promoting effect on English teaching.

2.3.2. Cultural behavior identity

Table 2. Statistical data on cultural behavior (%)

| Items | Approve | Indifferent | Disapprove |
|---|---------|-------------|------------|
| I prefer celebrating Western festivals (e.g., Christmas, Valentine's Day, April Fool's Day) | 89% | 4% | 7% |
| I tend to choose Western fast food and beverages such as KFC, McDonald's, and Coca-Cola in daily life | 80% | 7% | 13% |
| Going Dutch when dining out | 95% | 3% | 2% |
| I think Western music, movies and other audio-visual works are better than domestic ones | 55% | 10% | 35% |

From the data in **Table 2**, it can be concluded that Chinese college students tend to prefer Western festivals to a certain extent in terms of cultural behavior, reflecting their relatively low identification with Chinese culture in the field of festivals. College students also generally recognize the popularity of Western fast food in China. Especially in terms of payment habits when dining out, 95% of students support the Western practice of going Dutch. Regarding the view that "Western music, movies and other audio-visual works are superior to Chinese works," students hold a more rational attitude; only 55% of students agree, 35% clearly disagree, and 10% are in a state of vague or uncertain cognition. Overall, college students have a high degree of identification with Western culture in specific cultural behaviors.

2.3.3. Value identity

Table 3. Statistical data on value identity (%)

| Items | Strongly Agree | Agree | Not Sure | Disagree | Strongly Disagree |
|--|----------------|-------|----------|----------|-------------------|
| In the process of learning about foreign cultures, do you think some concepts in traditional Chinese culture are relatively imperfect? | 14% | 23% | 8% | 35% | 20% |
| Many young people in society advocate Western individualistic values. What is your opinion? | 9% | 36% | 0% | 50% | 5% |

The two questions in **Table 3** focus on Chinese and Western values. From the data, although less than half of the students believe that traditional Chinese culture is inferior to foreign cultures and that Western individualistic values are more worthy of advocacy, the proportion is close to 50%. This result indicates that the values of contemporary college students are significantly impacted and influenced by Western culture, and thus tend to tilt towards the West in the shaping and formation of their own values.

2.3.4. Religious and political system cultural identity

Table 4. Statistical data on religious and political system cultural identity (%)

| Items | Completely Unacceptable | Partially Unacceptable | Not Sure | Basically Acceptable | Completely Acceptable |
|---|-------------------------|------------------------|----------|----------------------|-----------------------|
| Western countries often criticize China's socialist democracy. Can you accept it? | 35% | 52% | 8% | 5% | 0% |
| Many young people now recognize Western political systems such as democracy and the rule of law. Can you accept it? | 2% | 21% | 10% | 56% | 21% |
| Many people now join Western religions such as Christianity. Can you accept it? | 3% | 20% | 3% | 29% | 45% |

Combined with the survey data on college students' identification with Chinese and Western religious and political cultures in **Table 4**, the following conclusions can be drawn: Faced with Western countries' frequent criticisms of China's socialist democracy, college students hold positive and correct values, with 87% clearly expressing their firm stance in safeguarding Chinese culture. At the same time, the data shows that most college students recognize the advanced nature of Western democratic, political, and legal system cultures and are willing to accept them. In the survey on the acceptance of Western religious culture, 74% of college students hold a tolerant attitude towards Chinese people joining Christianity. Although this result does not mean they have the willingness to join themselves, it at least reflects their tendency to identify with Western religious culture.

The summary of the questionnaire survey data shows that contemporary college students generally tend to identify with Chinese culture, but the degree is not very high (accounting for nearly half). At the same time, more than half of college students identify with Western culture and values in many aspects, and even tend to favor Western culture in behavioral experiences. This indicates that China's foreign language teaching has indeed affected college students' identification with Chinese culture to a certain extent. Some college students also show certain confusion in cultural identity, leading to vague or uncertain choices. Therefore, we must not take it lightly, we need to guard against the gradual penetration of Western cultural imperialism into college students, and attach importance to strengthening students' Chinese cultural identity education in foreign language teaching.

2.4. Interviews

2.4.1. Purpose and content of interviews

The purpose of this interview is to understand the specific level of college students' cultural identity and their ability to express Chinese cultural content in English. The interview content consists of three questions. Three students were randomly selected from freshmen, sophomores and juniors respectively to complete the interviews independently. The specific interview content is as follows:

- (1) What problems do you think exist in the current foreign language and cultural teaching classrooms?
How should they be solved?
- (2) How would you rate students' ability to express Chinese culture in English: Low ☐ Average ☐ High ☐ Performance?
- (3) What suggestions do you have for integrating target language culture and native culture in foreign language and cultural teaching?

2.4.2. Conclusions and analysis of interviews

After nearly a month of interviews, the nine interviewees reflected common problems in foreign language and cultural teaching classrooms: Firstly, the cultural content involved is relatively insufficient; secondly, teachers talk more about Western culture and barely mention Chinese culture in class; thirdly, the form of teaching cultural content by teachers is relatively single and boring. More than 50% of students believe that their ability to express Chinese culture in English is low; 30% think it is average; 20% believe there is great room for improvement. Specifically, they struggle with untranslatable keywords in oral expression, unsmooth content, occasional inability to express ideas accurately, and even difficulty understanding Chinese texts. The main reasons include insufficient cultural input, single practice methods, and a lack of learning motivation. Regarding solutions and suggestions, five interviewees proposed that teachers can integrate relevant cultural knowledge into classroom teaching. For example, targeted exercises can be carried out in the first few minutes of class, focusing on cultural knowledge of China and English-speaking countries, with special emphasis on cultural differences. Students can be guided to compare Chinese and Western cultures through discussions or debates. Taking the teaching of etiquette-related knowledge as an example, students can be organized to discuss differences between Chinese and Western behaviors, eating habits, etc. When teachers explain texts involving Western cultural background knowledge, they should first remind students to pay attention to it, then analyze similarities and differences in combination with Chinese culture, and answer questions promptly. Another six interviewees suggested making full use of audio-visual resources and intuitive teaching aids to help students better absorb and experience their own and foreign cultures.

The interview results indicate that contemporary Chinese college students are quite lacking in the ability to express Chinese cultural content in English, which is consistent with the fact that we have not paid sufficient attention to Chinese culture in daily English teaching^[8]. During the interviews, it was found that most students want to express familiar poems or topics but do not know how, reflecting their strong interest in Chinese culture and desire to improve their ability to express Chinese culture in English.

4. Discussion on cultural identity education in English teaching

In the context of cultural globalization, various national cultures not only show distinct differences and rich diversity but also their cultural identities encounter many challenges and impacts. For a long time, China's foreign language education has tended to separate from the mother tongue and mother tongue culture, and has an insufficient understanding of the value of mother tongue culture in foreign language teaching. This has led to the long-term lack of autonomy in Chinese English teaching, which has become a simple copy of British and American English, disconnected from the actual needs of Chinese society^[9,10]. This model of "valuing learning over application" has to a certain extent, affected students' formation of objective and positive identification with their own culture. Particularly importantly, as the backbone of the country's future and the core force of social development, the cultural identity of contemporary college students directly affects the inheritance and continuity of national culture.

Based on this, to promote the cultivation of college students' cultural identity, efforts can be made in the following four aspects:

- (1) Build correct cultural cognition: Optimize the cultural attitude orientation in English education;
- (2) Create cross-cultural contexts: Improve the cultural acceptance process in English education;

- (3) Cultivate cultural skills: Optimize cross-cultural communication strategies in English education;
- (4) Deepen educators' humanistic care: Improve the main cultural literacy of English teachers.

5. Conclusion

It is difficult to learn a language well without understanding the cultural characteristics of that language. Language carries cultural connotations, and it is unrealistic to learn a language well by separating it from its cultural background. On the contrary, the more thoroughly one grasps the historical culture, traditional customs, lifestyle, and details of the country where the target language is spoken, the more accurately one can understand and flexibly use the language. Based on this, two advocacies are put forward: (1) Integrate mother tongue culture: Avoid the generation of subtractive cultural identity; (2) Explore the core of target language culture: Help cultivate productive cultural identity.

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Research on the Construction and Practice of Primary School Mathematics Large-Unit Teaching Model Based on Conceptual Understanding: Taking the Unit “Parallelograms and Trapezoids” as an Example

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Abstract: Under the guidance of core competencies, the reform of primary school mathematics teaching urgently needs to go beyond the superficial teaching of knowledge and skills, and construct a new teaching paradigm aimed at promoting students' conceptual understanding and endogenous literacy. Addressing the long-standing problems in the field of graphics and geometry, such as fragmented knowledge, superficial thinking, and vague literacy goals, this study takes Erickson's "concept-based" curriculum and teaching theory as the meta-framework, integrates domestic research on big idea teaching, and constructs a three-dimensional collaborative large-unit teaching model of "Knowing—Doing—Understanding" (KUC). Taking the unit "Parallelograms and Trapezoids" in primary school mathematics (People's Education Press edition) as an empirical carrier, the paper systematically elaborates the complete design path from "extracting subject big ideas" and "establishing conceptual perspectives" to "designing hierarchical guiding questions," "constructing performance evaluation" and "sequencing iterative learning activities," and develops an anchoring performance task of "campus transformation designer". Practice shows that this model can effectively drive students' thinking to leap from "factual memory" to "concept construction," providing a theoretical reference and practical model for the transformation of competency-based classrooms.

Keywords: Big idea teaching; Concept-based; Graphics and geometry; Core competencies; Large-unit design; Consistency of teaching, learning and evaluation

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1. Problem proposal: Practical dilemmas and theoretical demands of primary school mathematics teaching in the literacy era

Competency-oriented curriculum reform aims to cultivate students' mental flexibility when facing various

complex and open situations^[1]. One of the keys to achieving this goal is to attach importance to and promote the development of students' conceptual understanding^[2]. The Compulsory Education Mathematics Curriculum Standard (2022 Edition) has established curriculum goals oriented by the core competencies of “Three Abilities”, marking the official transition of primary school mathematics education from “double basics” to “competency-based”^[3]. However, examining the current teaching scene, there are still three interwoven deep-seated dilemmas:

Firstly, the lack of a knowledge structure leads to weak cognitive schemas and insufficient transfer ability. Restricted by the traditional linear class hour logic, contents related to graphics and geometry are often treated atomically. Students acquire mostly fragmented “concept labels” and “property conclusions,” making it difficult to construct a systematic and networked cognition of the internal genealogy of relevant graphic systems and the core subject idea that spatial relationships determine graphic properties. This fragmented knowledge is difficult to transform into an adaptive cognitive framework for coping with complex situations, resulting in knowledge inertia and transfer failure.

Secondly, the superficialization of thinking training inhibits the development of higher-order geometric thinking and core subject competencies. In current classrooms, the simplified inquiry model of “observation-instruction-verification” is still prevalent. Students' cognitive activities are confined to factual memory and shallow operations, depriving them of the opportunity to conduct in-depth questioning on essential subject issues such as the construction logic of geometric concept systems and the inherent connections between graphic properties, thereby hindering the development of higher-order geometric thinking such as conjecture, argumentation and systematization^[4].

Thirdly, the vagueness of literacy goals leads to structural disconnection in the consistency of teaching, learning and evaluation. Although the new curriculum standard clearly describes literacy dimensions such as spatial awareness and geometric intuition, the evaluation focus dominating daily teaching still stubbornly points to the mechanical memory of definitions, accurate repetition of properties and rapid identification of standard graphics. This evaluation culture conflicts with the comprehensive and situational characteristics of literacy goals, resulting in the systematic narrowing or even neglect of higher-order literacy goals in key links of teaching and evaluation^[5].

The “concept-based” theory advocated by international curriculum experts H. Lynn Erickson and Lois A. Lanning provides a powerful theoretical fulcrum for solving the above dilemmas. The theory points out that curriculum design in the literacy era must upgrade from the two-dimensional model of “knowledge + skills” to the three-dimensional model of “knowledge—process—conceptual understanding”^[6]. In this model, conceptual understanding is at the core, serving as the cognitive anchor for students to achieve knowledge integration and far transfer. The value of conceptual understanding lies in realizing transferability within a wider range by forming general ideas about the meaning of things^[7]. Based on this and deeply integrating domestic research on big idea teaching, this study is committed to constructing a KUC model of primary school mathematics large-unit teaching with conceptual understanding as the core, and conducts systematic design explanation and empirical exploration with the unit “Parallelograms and Trapezoids” as an example.

2. Theoretical basis: Research evolution and subject adaptation of big idea teaching

In recent years, around the implementation of core competencies, research on big idea teaching in China's

educational circle has moved from concept introduction to in-depth subject construction, providing rich theoretical nourishment for the model construction of this paper.

2.1. Connotation distinction between conceptual understanding and subject big ideas

The transformation from everyday concepts to scientific concepts, and from naive theories guiding daily actions to scientific theories based on disciplinary practice norms, neither occurs inevitably nor transitions naturally^[8]. “Conceptual understanding” emphasizes the meaningful construction and flexible application of core big ideas in disciplines. Liu (2022)^[9] pointed out in *Big Idea Teaching: Competency-Oriented Unit Overall Design* that big ideas are “located at the center of curriculum learning, which can not only reveal the laws behind subject knowledge but also connect the real world, with extensive transfer value”. They endow factual knowledge with meaning and promote its structuring. From the perspective of children’s mathematics education, Wu (2022)^[10] emphasized that big ideas are “core clues running through the entire process of primary school mathematics learning”, which help children “build ‘load-bearing walls’ and break through ‘partition walls’,” realizing the integration of knowledge and positive transfer of learning.

2.2. Extraction path and teaching research of mathematics big ideas

How to extract big ideas from mathematics curriculum standards and subject essence is the key to practice. Ma (2022) proposed the idea of extracting big ideas based on “learning themes”. Liu (2022) systematically elaborated the extraction strategy combining “top-down” (based on curriculum standards and subject essence) and “bottom-up” (based on students’ cognitive difficulties and life reality). In the field of graphics and geometry, core competencies such as “spatial awareness,” “geometric intuition,” and “model thinking” provide a solid basis for the accurate positioning of big ideas in this unit.

2.3. Research on design and evaluation of large-unit teaching

In terms of implementation, large-unit teaching is regarded as an ideal carrier for implementing big idea teaching. Cui (2019) emphasized that large-unit design must be organized around core problems arising in real situations to achieve “consistency of teaching, learning and evaluation.” Based on decades of practice, Wu (2022) proposed that the overall unit teaching of primary school mathematics should follow the principles of “establishing structure in connection, deepening understanding in comparison, and improving accomplishment in application.” In terms of evaluation, performance evaluation is highly respected because it can directly assess students’ understanding and transfer level of big ideas.

3. Model construction: KUC three-dimensional collaborative framework of primary school mathematics large-unit teaching

Disciplinary conceptual knowledge can only be transformed into individual personal knowledge through the generation of personal understanding^[11]. Based on Erickson’s theory and deeply integrating domestic research results, we have constructed the “KUC” three-dimensional model of primary school mathematics large-unit teaching (**Table 1**). The model emphasizes that Knowledge (K) and Skills (D) are the cornerstones and carriers for constructing Conceptual Understanding (U), while Conceptual Understanding (U) injects soul and direction into the acquisition of Knowledge (K) and Skills (D). The three are interdependent and mutually promoting, forming a cognitive development closed loop of “factual perception—skill practice—concept formation—

reflection and application,” ultimately pointing to the generation of core competencies.

Table 1. Constituent elements of the KUC three-dimensional model for the large unit “Parallelograms and Trapezoids”

| Dimensions | Core connotation in primary school mathematics | Specific manifestations and theoretical analysis of this unit |
|--|---|--|
| Knowledge Dimension (Knowing) | Stable declarative knowledge forming the foundation of mathematics, including mathematical facts, terms, symbols, definitions, axioms, etc. | Precise definitions of parallelism and perpendicularity: “Two straight lines in the same plane that do not intersect are called parallel lines”; “If two straight lines intersect at a right angle, we say the two straight lines are perpendicular to each other”. These are the logical cornerstones and starting points of geometric reasoning. |
| Skill Dimension (Doing) | Procedural knowledge and cognitive strategies executed by students to explore mathematical meanings and solve problems, including calculation, drawing, reasoning, modeling, communication, etc. | Operational skills in geometric drawing: proficiently using tools such as set squares, straightedges, and protractors to standardly draw parallel lines, perpendicular lines, and specified parallelograms and trapezoids. Higher-order skills in mathematical modeling and problem-solving: transforming spatial problems in the real world into geometric models, and comprehensively using learned knowledge and strategies to seek creative solutions. |
| Conceptual Understanding Dimension (Understanding) | Profound, lasting and transferable conceptual cognition of core big ideas in mathematics. Composed of “concepts” (abstract ideas) and “generalizations” (propositions expressing fundamental relationships between concepts). This is the ultimate pursuit and deep goal of teaching. | Core concepts: Spatial relationship, invariance, classification, dimension. Core generalization: Humans have constructed the classification and reasoning system of geometry by defining and exploring stable spatial relationships between graphic elements (such as parallelism and perpendicularity); understanding and mastering these relationships is the key for us to interpret spatial order, conduct creative design and solve problems. |

4. Practical empiricism: Application of the KUC model in the unit “Parallelograms and Trapezoids”

Taking the unit “Parallelograms and Trapezoids” (Grade 4, Volume 1, People’s Education Press edition) as an example, this section details the complete teaching design path based on the KUC model.

4.1. Accurate positioning of big ideas and core generalizations

The conceptual perspective established for this unit is “spatial relationships,” and the core generalization is: “Humans have constructed the classification and reasoning system of geometry by defining and exploring stable spatial relationships between graphic elements (such as parallelism and perpendicularity); understanding and mastering these relationships is the key for us to interpret spatial order, conduct creative design and solve problems.” This generalization serves as the “conceptual anchor” integrating the entire unit’s learning.

4.2. Design of hierarchical guiding question chains

To propose mathematical problems means the following for students:

- (1) Students can put forward mathematical problems, including mathematical expressions and mathematical graphs based on existing contexts;
- (2) Students can add reasonable information to reconstruct the original problems^[12]. As a cognitive activity for students to exert creative thinking^[13], integrating problem posing as a teaching method into actual classroom teaching by teachers can promote students’ conceptual understanding^[14,15].

A problem chain is the core engine that drives students' cognition to climb from specific facts to abstract concepts. We have designed three levels of problems advocated by Erickson:

- (1) Factual questions (F): Questions pointing to the Knowledge Dimension (K), such as inquiries about definitions of relevant concepts and characteristics of graphics.
- (2) Conceptual questions (C): Questions connecting the Knowledge/Skill Dimensions and the Conceptual Understanding Dimension, such as inquiries about the reasons for graphic classification criteria and the invariant properties of graphics.
- (3) Philosophical/transfer questions (P): Questions pointing to the transfer and application of the Conceptual Understanding Dimension, such as inquiries about the application of graphic spatial relationships in real life and creative design based on such relationships.

4.3. Construction of the “Campus Transformation Designer” performance evaluation system

4.3.1. Task scenario

The school plans to transform an idle area into a “creative activity park” and solicits design proposals from students.

4.3.2. Core requirements

- (1) Functional area planning: The design plan must include specific graphic functional areas, with clear marking and written explanations of graphic characteristics.
- (2) Road system design: The road system must include specific spatial relationship designs, with standard symbol marking and explanations of design reasons.
- (3) Design proposal demonstration: Prepare an oral report to explain design ideas, focusing on the application of spatial relationships and the advantages of the plan.

4.3.3. Evaluation rubric

Comprehensive evaluation is conducted from three dimensions, knowledge understanding, skill application, and concept transfer, with four levels set to ensure the consistency of teaching, learning and evaluation.

4.4. Sequencing of iterative learning activities

The entire learning process is designed as three spiral and iterative stages, taking about 6 class hours:

- (1) Stage 1: Initial exploration of facts and concepts (about 2 class hours): Abstract geometric graphics from life examples and learn standardized mathematical definitions and symbolic expressions.
- (2) Stage 2: Skill and concept deepening (about 2 class hours): Operate deformable teaching tools to experience graphic invariance, verify graphic properties through multiple methods, and construct a structured knowledge network.
- (3) Stage 3: Understanding transfer and achievement creation (about 2 class hours): Fully implement the “campus transformation designer” project, with students completing design drawings, making models and preparing reports to solidify and sublimate conceptual understanding.

5. Discussion and reflection: Practical boundaries and optimization paths of the model

The effective implementation of the KUC model places higher requirements on teachers' curriculum understanding and design capabilities, requiring careful handling of the following relationships in practice.

5.1. Balance between conceptual rigor and children's cognition

Graphics and geometry concepts are highly abstract. Teaching should adhere to the principle of intuition, allowing students to approach the essence of concepts through intuitive materials, counterexample comparison and embodied operations.

5.2. Guarantee of reliability, validity and efficiency of performance evaluation

In large classes, performance evaluation faces challenges of being time-consuming and subjective. Countermeasures include developing detailed evaluation rubrics, implementing multi-subject evaluation mechanisms, and exploring the use of information technology to improve efficiency.

5.3. Construction of a support system for teachers' professional development

The model requires teachers to shift from "teaching textbooks" to "using textbooks to teach", requiring solid subject content knowledge and curriculum design capabilities. It is necessary to construct a "research-training-practice-reflection integrated professional learning community" to realize continuous professional empowerment of teachers.

6. Research conclusions and future prospects

6.1. Research conclusions

The KUC three-dimensional large-unit teaching model constructed and practiced in this study provides an embodied path for the transformation of primary school mathematics classrooms towards competency orientation through big idea integration, question chain driving and performance evaluation anchoring. Practice shows that this model can effectively solve knowledge fragmentation, deepen thinking levels, and ensure the consistency of teaching, learning and evaluation.

6.2. Future prospects

Future research can further expand the application scenarios of the model, optimize it based on student differences, integrate digital technology, and verify its long-term effects, so as to provide more comprehensive support for the in-depth development of primary school mathematics teaching reform.

Disclosure statement

The authors declare no conflict of interest.

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Exploration of Digital Transformation Empowering Carbon Emission Reduction in Industrial Enterprises Under the “Dual Carbon” Goal

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Abstract: As key supervised entities for carbon emissions, the effective carbon reduction of industrial enterprises is crucial to the achievement of the “Dual Carbon” goal. With the arrival of the digital era, digital transformation has become an inevitable path for the high-quality development of all industries, providing new ideas for carbon emission reduction in industrial enterprises. This paper aims to explore the necessity of carbon emission reduction in China's industrial sector and the importance of digital transformation for achieving carbon emission reduction, analyze the impact of digital transformation of industrial enterprises on carbon emission reduction, and explore effective paths for digital transformation to reduce carbon emissions. It is of great significance for the coordinated development of low-carbon transformation and digital transformation of industrial enterprises.

Keywords: Industrial enterprises; Digital transformation; Carbon emission reduction

Online publication: December 12, 2025

1. Necessity of carbon emission reduction in China's industrial sector

In recent years, the issue of carbon emissions has attracted attention from all sectors of society. In 2021, global energy-related carbon dioxide emissions increased by 5.6% year-on-year to 33.9 billion tons, of which China's carbon dioxide emissions were 11.9 billion tons, accounting for 35% of the global total^[1]. Therefore, China should assume the responsibility for carbon emission reduction. In addition, against the background of the proposal of the “Dual Carbon” goal, China should actively, steadily and in-depth promote carbon peaking and carbon neutrality based on the characteristics of energy and resource endowments, and implement carbon peaking and carbon neutrality actions in an orderly manner^[2]. As of February 2024, industrial carbon emissions accounted for more than 70% of the national total. Meanwhile, China's carbon emission intensity in 2019 decreased by 48.1% compared with 2005, while the industrial carbon emission intensity decreased by 57.8%. It can be seen that the industry is a key monitored industry for national carbon emissions and a key field for

achieving the carbon peaking and carbon neutrality goals. As key economic entities in the industrial sector, industrial enterprises are the main actors in practicing the “Dual Carbon” strategy^[3]. Their energy consumption and pollutant emissions are higher than those of other enterprises, making it imperative to implement carbon emission reduction actions.

2. Ideas of digital transformation empowering carbon emission reduction in industrial enterprises

Currently, the development of the digital economy is in the ascendant, and digital transformation has become a forerunner for the high-quality development of all industries. With the large-scale application of digital technologies, accelerating the digital transformation of traditional industries has become an important task and core link for in-depth optimization of the supply-demand structure, promotion of industrial manufacturing upgrading, and continuous expansion of the digital economy^[4]. As a traditional energy-consuming industry, the industrial sector should prioritize digital transformation. Under the constraints of the “Dual Carbon” goal, the emerging low-carbon economy and the accelerating digital economy advance side by side and collide with each other, providing new development directions for industrial enterprises. On the one hand, integrating the “Dual Carbon” goal into the overall social development has led enterprises to take the path of low-carbon development. Carbon emission reduction has become the primary task for enterprises to achieve low-carbon development and an inevitable direction to gain market competitive advantages. Enterprises obtain competitive advantages by reducing carbon emissions, and can also achieve good returns in the market after gaining competitive advantages. On the other hand, compared with developed countries, China faces a tight schedule, arduous tasks and greater difficulties in achieving the “Dual Carbon” goal, requiring low-carbon and green reforms in social, economic, energy and technological systems. Digital transformation brings new momentum for enterprises’ carbon emission reduction, and digital technology is an important means for enterprises to achieve the “Dual Carbon” goal.

Digital transformation provides solutions to the carbon emission problems faced by industrial enterprises. First, in terms of the manufacturing link, due to the requirements of digital transformation, industrial enterprises must adjust their production models, adopt new digital technologies, optimize production processes, enhance equipment operation efficiency, and refine the management of production processes. Companies can more effectively manage data on their energy use, carbon emission levels, and environmental protection and energy-saving measures^[5], which can not only increase the production capacity and efficiency of industrial enterprises but also effectively reduce carbon emissions. Second, from the perspective of energy use, if industrial enterprises over-rely on fossil fuels, carbon emissions will increase, so it is necessary to control carbon emissions by reducing energy consumption. Through information integration, visual monitoring and other methods, digital transformation reduces energy consumption in the production process, improves the utilization efficiency of traditional fossil energy, and accelerates changes in the energy structure. Finally, from the perspective of industrial development, digital transformation accelerates enterprises’ transformation from resource-driven operation methods to innovation-driven operation strategies, thereby significantly improving productivity and reducing information asymmetry among upstream, midstream and downstream of the industrial chain. This is more conducive to controlling carbon emissions related to the manufacturing link^[6]. At the same time, all stakeholders can benefit from it and promote the reduction of carbon emissions in the process of

enhancing their own interests, ultimately achieving a Pareto optimal state of the whole society^[7]. In summary, relying on digital technologies, industrial enterprises transform from high energy consumption, low efficiency and high emissions to greenization, high efficiency and low emissions, realizing the “parallel development” of digital transformation and green transformation.

3. Impact of digital transformation of industrial enterprises on carbon emission reduction

Digital transformation includes three parts: digital infrastructure construction, digital technology application and digital development. Digital infrastructure construction is the foundation of digital transformation, providing strong support for it; digital technology application is the basic manifestation of digital transformation, emphasizing the popularization and application of digital technologies; digital development is an extension of digital technology application, consisting of digital industrialization and industrial digitalization.

3.1. Impact of digital infrastructure construction on carbon emission reduction

As an infrastructure system driven by data innovation and composed of data processing capacity facilities based on communication networks, digital infrastructure construction constitutes a key support for promoting enterprises’ digital transformation^[8]. This concept includes not only elements such as sensor endpoints, 5G networks, big data centers and industrial internet but also the upgrading or updating of traditional physical infrastructure through the use of emerging information technologies such as the Internet of Things, edge computing and AI. Under the “Dual Carbon” goal, promoting the construction of digital low-carbon infrastructure helps improve management and operational efficiency and reduce the consumption of personnel and resources^[9]. Based on this, digital infrastructure should be combined with traditional high-carbon emission fields, eliminate outdated high-energy-consuming equipment, and give full play to the enabling role of digital infrastructure.

At the enterprise level, digital infrastructure has gradually integrated into enterprise development with the tide of the times and technological innovation. From the enterprise’s perspective, with the changes of the times and technological progress, enterprises have begun to integrate these advanced information tools into their businesses. For example, a large number of machine learning algorithms are used to automatically control various operating systems in factories to better monitor the entire product life cycle and make accurate data statistics on various key indicators such as power consumption and manufacturing costs^[10]. This method can not only greatly increase our sense of responsibility for environmental protection but also significantly reduce the generation of greenhouse gas pollutants, promote the improvement of energy use efficiency, and reduce enterprise carbon emissions to a certain extent. Digital infrastructure exerts positive externalities and brings obvious economies of scale to enterprises.

3.2. Impact of digital technology application on carbon emission reduction

When the construction of digital infrastructure is gradually improved, the application of digital technologies follows. In the digital economy era, digital technology endows means of production with digital attributes, realizing in-depth integration in all links of production. For the industrial sector, the progress of digital technology means the gradual improvement of the efficiency of fossil energy use in the production process, leading to a reduction in carbon emissions^[11]. Since 2010, the Ministry of Industry and Information Technology

has actively promoted methods to implement conservation measures in the industrial sector: achieving this goal by using digital technology to establish real-time monitoring and management systems.

Industrial enterprises introduce digital technologies. When the application of digital technologies reaches a certain scale, they can reduce carbon emissions by reducing enterprises' fossil energy consumption, providing motivation for the achievement of the "Dual Carbon" goal. First, digital technology has transformed the current energy management system, improved processing and conversion speed, optimized the effect of energy transmission, distribution and storage, and significantly reduced management costs in the traditional manufacturing stage. Second, the application of digital technology can promote the transparency of carbon emission data, which further accelerates the company's technological innovation to reduce energy consumption. Because digital technology makes the production process more refined and mechanical equipment realizes automatic control, the output rate of the company's products and the energy use effect in the process flow are enhanced. In this way, the company can more effectively grasp digital technology to share information and accurately predict market demand. It can be seen that the application of digital technology improves the efficiency of enterprise resource utilization and reduces enterprises' fossil energy consumption.

3.3. Impact of digital development on carbon emission reduction

As the main form of digital economic development, one of the important characteristics of digital development is industrial digitalization, which means upgrading traditional industries and transforming them into new forms through the use of advanced digital technologies^[12]. This process includes using the latest digital technologies, focusing on the core points of value creation, and focusing on data-driven to comprehensively, in-depth and continuously reform the entire industrial chain. The essence of digital industrialization lies in the progress of digital technology, which can bring us various products and services based on digital technology, such as digital technology and equipment. As traditional energy-consuming enterprises, industrial enterprises should deeply integrate the digital economy with the real economy and help the industry achieve transformation and upgrading through their own efforts.

When digital development reaches a certain scale, the scale of the digital industry increases significantly. According to the information asymmetry theory, industrial enterprises break enterprise boundaries, promote the exchange of various information among industrial subjects, and realize industrial transformation and upgrading^[13]. With the progress of digitalization, the economies of scale it generates can effectively reduce environmental pollution and emission reduction costs, and increase investment in environmental protection technologies, thereby promoting enterprises to improve carbon emission reduction effects^[14]; endowing industrial development with new momentum through digital means can enhance resource utilization efficiency and optimize resource allocation, thereby reducing carbon emissions caused by the "extensive" development mode^[15]. It can be seen that at this time, digital transformation can bring positive carbon emission reduction effects.

4. Implementation paths of digital transformation empowering carbon emission reduction in industrial enterprises

4.1. Give play to the leading role of the government

To accelerate the development of the digital economy, administrative departments at all levels can provide policy and financial support for industrial enterprises' digital transformation according to specific conditions,

invest in the construction of digital public services to realize the digital reform of public service popularization, attract enterprises to introduce digital infrastructure, ensure the practical application of digital technologies, and thus help enterprises carry out digital transformation. In addition, environmental supervision should be fully used to stimulate enterprises' low-carbon orientation. Due to the possible increase in enterprise costs caused by low-carbon transformation, such as insufficient financial resources, technical capabilities, and talent accumulation, this is a huge pressure for small and medium-sized industrial enterprises. Therefore, precise assistance must be provided, the intensity of environmental supervision should be enhanced, legal systems should be implemented into enterprise action plans, and enterprises should be encouraged to participate in carbon emission reduction activities, thereby helping to achieve the "Dual Carbon" goal in detail.

4.2. Accelerate the development of digital transformation

Industrial enterprises should clarify their transformation ideas according to their own conditions, explore digital transformation paths in line with their development direction, and increase the intensity of digital transformation, including the research and development and application of digital technologies. When carrying out digital transformation, enterprises must inevitably change their production methods, introduce digital technologies, optimize production processes, improve equipment operation efficiency, and strengthen the accuracy of production process management. At the same time, they need to make full use of data resources, release the potential of data, and realize intelligent enterprise decision-making, thereby improving productivity and work efficiency.

4.3. Drive carbon emission reduction through digital transformation

The application of digital technologies can penetrate into the industrial field and major carbon emission industries, thereby reducing the use of energy and resources, and improving the energy efficiency, cost-effectiveness, risk prediction, and management decision-making capabilities of traditional industries.

Overall, it improves energy-saving effects, reduces production costs, and enhances product quality and economic benefits. To achieve the "Dual Carbon" goal, we need to base ourselves on energy conservation and emission reduction across the entire industrial chain. At present, consumption at the end of the industrial chain has become one of the important sources of carbon emissions. Therefore, it is not only necessary to actively implement energy conservation and emission reduction measures on the supply side, but also to reduce carbon emissions by restricting consumption, thereby promoting green consumption behavior and stimulating the supply side to take more energy-saving measures. At the same time, focus on green development, advocate the green orientation of digital technology research and development, and digital transformation empowers green technological innovation of industrial enterprises, thereby giving play to the leading role of green technological innovation. Digital transformation has a key impact on reducing energy consumption and enhancing resource utilization efficiency. Promoting the transformation of the industrial sector towards intelligence and environmental protection through digital technology is an important current trend. By applying digital technology to improve links such as energy management and decision-making regulation, traditional manufacturing can move towards a more efficient and greener path. When digital transformation comprehensively promotes the overall improvement of industrial enterprises, it also makes the integration of green technology possible, which helps to further improve resource use efficiency and ultimately achieve the goal of sustainable development.

4.4. Coordinated development of enterprises' internal and external environments

At present, there are still many challenges in promoting carbon emission reduction through the digital transformation of the industrial sector. Among them, how to better promote the digital transformation of the industrial sector is a problem that needs to be considered and solved by all social parties such as the government, enterprises and individuals. To give full play to the carbon emission reduction effect of the digital transformation of industrial enterprises, internally, enterprises should base themselves on their own conditions, enhance environmental awareness and accelerate digital transformation, lead enterprises in technological upgrading through digital transformation to reduce energy consumption. Externally, enterprises should attach importance to the supporting role of the external environment, effectively promote healthy competition among enterprises, and establish digital sharing platforms with external parties to achieve data sharing and reduce the cost of digital transformation. Enterprises' internal and external efforts should be combined to promote the coordinated development of digital transformation and carbon emission reduction of industrial enterprises.

Disclosure statement

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Research on the School-Enterprise Integration Education Model in Vocational and Technical Colleges: Taking the Virtual Reality Technology Application Major as an Example

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Abstract: With the development of the digital economy, virtual reality (VR) technology has gradually become one of the core components of information technology in the new era, widely used in education, medical care and other fields. The market has put forward an urgent demand for VR technical talents with practical and industry adaptability. Vocational and technical colleges shoulder the mission of cultivating skilled talents, and the teaching effect of their VR technology application major affects the talent supply for industry development. However, they also face problems such as disconnection from the industry and insufficient experience of teachers, making it difficult for students to meet the requirements of positions. The application of the school-enterprise integration education model helps break this predicament, promote the connection between education and enterprise practice, give play to the advantages of both parties, and form a new education pattern. From the perspective of the VR technology application major, this paper analyzes the application value of the school-enterprise integration education model and puts forward specific educational practices, aiming to provide reference for colleges and universities to adjust professional education plans.

Keywords: Vocational and technical colleges; School-enterprise integration; Virtual reality technology application major

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1. Introduction

As the virtual reality industry enters an accelerated development stage, China has included VR technology in the key areas of the digital economy development plan and issued relevant policies to clearly cultivate high-quality skilled talents in this field. Vocational and technical colleges take serving regional economy and cultivating skilled talents as their school-running orientation and shoulder the mission of cultivating VR technology application talents. From the actual situation of professional talent training, they are facing many challenges.

For example, the rapid update of technology and the continuous upgrading of requirements for talent skills, but the curriculum setting of vocational and technical colleges is difficult to keep up with the needs of industry and technology development, which is likely to cause disconnection between teaching and enterprise practical application. Based on this, the application of the school-enterprise integration education model has become an important choice for the VR technology application major to break the development bottleneck. School-enterprise integration emphasizes the cooperation between schools and enterprises, promotes the integration of enterprise production, technical standards, and post needs with talent training, and facilitates the connection between learning, practice, and employment. The implementation of the school-enterprise integration model allows schools to leverage enterprise advantages to optimize practical teaching conditions. Teachers actively participate in enterprise work to improve their professional capabilities, helping students accumulate experience and enhance their skill levels.

2. Application significance of school-enterprise integration in the Virtual Reality technology application major of vocational and technical colleges

2.1. Comply with the development trend of the VR industry and alleviate the contradiction between supply and demand of industry talents

China's VR industry is in a stage of rapid development, with the industrial scale expanding day by day. The industry has put forward higher demands for technical talents, including VR content production and equipment debugging, resulting in an obvious talent gap^[1]. However, the education activities of vocational and technical colleges are disconnected from industry needs. Although many graduates have certain practical skills, they lack practical and industry adaptability, making it difficult to meet the requirements of enterprise positions, which is likely to cause problems such as difficulty in recruiting workers and employment difficulties. The implementation of school-enterprise integration enables vocational and technical colleges to establish good cooperative relationships with VR enterprises, set talent training plans in combination with enterprise post needs, appropriately adjust courses and teaching content, and ensure that the trained students master the skills required by enterprises^[2]. At the same time, enterprises can actively participate in the teaching of the VR technology application major in schools, provide students with post and project guidance, facilitate students to contact cutting-edge industry technologies, adapt to the work rhythm after graduation, and greatly shorten the post-adaptation period. The application of this model can not only cultivate a large number of technical talents for the VR industry, alleviate the contradiction between supply and demand of talents, but also accelerate the development pace of the VR industry.

2.2. Improve the school-running quality of vocational and technical colleges and enhance professional competitiveness

From the perspective of vocational and technical colleges, the VR technology application major is one of the emerging majors, and its school-running effect and professional competitiveness affect the long-term development goals of the school. The school-enterprise integration education model provides an important way for schools to adjust school-running conditions and improve teaching quality^[3]. On the one hand, VR enterprises can provide schools with advanced equipment, software, and teaching resources, helping schools build professional training bases and optimize practical teaching conditions. For example, enterprises can provide VR headsets and motion capture equipment to facilitate students in carrying out immersive practical

operations and improve their practical skills. On the other hand, enterprise experts can actively participate in school curriculum construction and teaching reform, help schools formulate curriculum systems that meet industry standards, promote the transformation of real enterprise projects into teaching cases, and effectively expand teaching content^[4]. In addition, through school-enterprise integration, vocational and technical colleges can strengthen the construction of teacher teams. Schools can select professional teachers to take temporary positions in enterprises, participate in enterprise project development and technological research and development, and improve teachers' practical ability and industry experience.

3. Practical countermeasures of the school-enterprise integration education model for the Virtual Reality technology application major

3.1. Construct a “School-enterprise collaborative” talent training system

To promote the implementation of the school-enterprise integration education model, it is necessary to attach importance to the construction of a school-enterprise collaborative talent training system. Vocational and technical colleges cooperate with VR enterprises to jointly formulate education plans, adjust curriculum systems, and actively develop teaching resources to ensure the consistency between education goals and enterprise post needs^[5]. From the perspective of formulating education plans, colleges and universities can invite technical backbones of enterprises to participate in the formulation process. Enterprises put forward requirements for talent training, knowledge, and skills in combination with their own positions and development conditions. Schools convert enterprise needs and set corresponding education goals in combination with their own school-running orientation and teaching resources to improve the rationality of education activities. For example, for VR content production positions, enterprises can require students to master skills such as 3D modeling, animation production, and VR engine development^[6].

Schools can set corresponding professional and practical content to help students master relevant skills and meet post needs. For the design of the curriculum system, docking national professional standards, taking post capabilities as the orientation, and formulating a modular curriculum system. Decompose the post capabilities of the VR industry into several capability modules, and each capability module corresponds to a corresponding curriculum module^[7]. For example, divide the post capabilities of the VR technology application major into VR basic capabilities, VR content production capabilities, VR equipment debugging capabilities, VR scene development capabilities and other modules, and set corresponding courses for each module, such as Fundamentals of Virtual Reality Technology. In terms of teaching resource development, schools and enterprises should jointly develop teaching resources such as textbooks, courseware, and training projects. Textbook compilation should combine real enterprise projects and cases, integrate the latest industry technologies and practical experience into textbook content, and ensure the practicality and timeliness of textbooks. Courseware production should adopt multimedia technology, integrate VR videos, animations and other elements to enhance the intuitiveness and interest of teaching^[8]. Training project development should be based on real enterprise projects, allowing students to carry out practical operations in simulated work scenarios to improve practical capabilities.

3.2. Build “School-enterprise co-constructed” training bases

First, from the perspective of the construction of on-campus training bases, vocational and technical colleges can actively build professional training centers with the support of enterprise funds and equipment. In the

training center, VR equipment and software, such as VR headsets and 3D scanners, can be equipped to meet students' needs for VR content production^[9]. At the same time, enterprises can select technical personnel to participate in the construction and management of the training center, facilitating schools to formulate relevant management and training plans, ensuring the operation of the training center, and improving the quality of practical teaching.

Second, for the construction of off-campus training bases, schools need to select VR enterprises with a certain scale and technical capabilities as off-campus training bases. Off-campus training bases can provide students with real work and practical scenarios, facilitating students to participate in project development, production practice, and other links under the guidance of mentors^[10]. Schools strengthen cooperation with off-campus training bases, sign relevant agreements, clarify the rights and obligations of both parties, and actively build a good management and training assessment system. For example, schools cooperate with VR game development enterprises to actively build off-campus training bases, encouraging students to practice in enterprises in the second semester of their junior year. Under the guidance of enterprise mentors, students can carry out VR game character design, program development and other work. After the internship, enterprises can issue relevant internship appraisals based on students' performance and combine internship results with students' academic performance.

Third, the construction of "virtual training bases" can also be explored. Use VR technology to build virtual training scenarios, and students enter the virtual scenarios through VR equipment for practical operations^[11]. Virtual training bases have the advantages of high safety and reusability, which can make up for the deficiencies of physical training bases. For example, for training in the VR medical field, due to the involvement of real patients and medical equipment, physical training has certain risks and costs. Through virtual training bases, students can carry out practical operations such as VR surgical simulation and medical record diagnosis in virtual hospital scenarios, which not only ensures the safety and effectiveness of training but also reduces training costs^[12].

3.3. Build a "Dual-qualified and dual-capable" teachers' team

The teachers' team is the key to the implementation of the school-enterprise integration education model. Vocational and technical colleges should strengthen the construction of the teacher's team for the VR technology application major, building a "dual-qualified and dual-capable" teacher team with solid theoretical knowledge and rich industry practical experience^[13]. On the one hand, strengthen the training of the practical capabilities of on-campus teachers. Schools should formulate teacher practical training plans, regularly select professional teachers to take temporary positions in cooperative enterprises, participate in project development or technological research and development. During their practice in enterprises, teachers should deeply understand the production process, technical standards and post needs of enterprises, learn cutting-edge industry technologies and practical experience, and integrate them into the teaching process. For example, schools can sign teacher practice cooperation agreements with VR enterprises, selecting 3-5 professional teachers to practice in enterprises for 3-6 months every year. Teachers participate in the development and production of VR projects in enterprises. After the practice, teachers need to submit practice reports and transform practice results into teaching cases for classroom teaching. At the same time, schools can also encourage teachers to participate in VR industry training, seminars and technical certification exams to improve teachers' professional level and industry recognition.

On the other hand, attach importance to the introduction of enterprise technical backbones and encourage them to serve as part-time teachers. Schools strengthen cooperation with VR enterprises, actively invite enterprise technical backbones and industry experts to serve as part-time teachers, helping students master professional courses and training projects. Part-time teachers often have rich industry experience and can integrate enterprise cases and technologies with professional teaching to improve the problem of on-campus teachers' lack of practical experience^[14]. For example, schools actively hire technical directors of VR enterprises to serve as part-time teachers, helping students understand the development trends of the VR industry and the application of the technology in different fields. Schools can also invite enterprise project supervisors to serve as training instructors, encouraging students to carry out VR project training and helping them solve problems encountered. At the same time, schools actively build a part-time teacher management mechanism, clarifying the positions, teaching requirements, and assessment standards of part-time teachers to effectively ensure teaching quality.

In addition, through the construction of a school-enterprise teacher sharing platform, the sharing of school-enterprise teacher resources can be promoted, and the allocation can be optimized^[15]. With the help of the platform, on-campus teachers and enterprise part-time teachers can carry out experience exchange and technical seminars to effectively improve teaching levels. For example, the platform regularly organizes school-enterprise teachers to conduct teaching seminars, analyzing the teaching methods and training plans of VR professional courses.

4. Conclusion

In summary, the school-enterprise integration education carried out by the VR technology application major in vocational and technical colleges can not only meet the development of the VR industry and alleviate the supply-demand contradiction of the industry, but also help improve the school-running effect of colleges and universities and enhance industrial market competitiveness. By building a school-enterprise collaborative education system and training bases, we can create a good environment for students to explore knowledge and help them master the knowledge and skills required by the market. With the development of the school-enterprise integration model, the VR technology application major is facing new development prospects. It is necessary to grasp the concept of school-enterprise integration education and actively carry out teaching innovation.

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Cultivating a Higher Education Talent Training Model Adapting to the Needs of Regional Economic Development

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Abstract: The cultivation of higher education talents is closely related to regional development. Adaptive talent training plays a key role in promoting regional industrial upgrading and facilitating coordinated and sustainable social development. Currently, there are problems such as the disconnection between talent training goals and industrial positioning, low matching degree between curriculum systems and actual needs, and insufficient effectiveness of school-enterprise collaborative education. To address these issues, it is necessary to construct a talent training framework linked with the regional economy through paths such as dynamically adjusting professional layout, strengthening the construction of “double-qualified” teachers’ teams, and deepening industry-education integration and collaborative education.

Keywords: Regional economy; Higher education; Talent training

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1. Introduction

With the deepening of the diversification and differentiation of China’s economy, higher education has become the main position for talent training. The talent education mechanism, adapting to local economic development, plays an increasingly important role in regional development. The emergence of new technologies and the upgrading of traditional industries have led to a continuous increase in demand for high-level professional talents, but there is still a great imbalance between the resources provided by higher education and the demand. Therefore, how to make higher education adapt to the trend of local economic development and cultivate professional talents with solid theoretical knowledge, practical ability, and strong creativity has become a common theme of educational reform and economic and social development. Based on this, this paper conducts an exploratory study on the role, current situation, causes, and countermeasures of talent training, aiming to provide methods for the positive interaction between the regional economy and higher education.

2. Significance of cultivating higher education talents, adapting to the needs of regional economic development

2.1. Promote the optimization and upgrading of the regional industrial structure

According to the actual needs of local economic development, enrich higher education resources and cultivate high-quality talents to provide core momentum for promoting local industrial upgrading^[1]. To accurately meet the development needs of local leading industries and emerging industries, higher education must adjust majors and formulate reasonable talent training programs to cultivate industrial talents with rich professional knowledge, strong practical ability, and innovative ability for regional industrial development. After these talents enter the local industrial development system, they can play a key role in many links, such as technological research and development, production process optimization, and management innovation. They can not only promote the quality upgrading of traditional industries but also accelerate the development of new industries. Ultimately, it realizes the transformation and upgrading of regional industries from the low end to the high end of the value chain, establishes a modern industrial structure meeting local characteristics, and enhances the core competitiveness of regional industries^[2].

2.2. Promote coordinated and sustainable development of the regional society

Cultivating higher education talents, adapting to the needs of regional economic development, plays an important role in promoting the balanced and sustainable development of the local economy and society. On the one hand, the aggregation of talents drives the development of local social undertakings such as technological innovation and cultural education, comprehensively improving the quality of local public services and the general quality of the public, and narrowing the gaps between urban and rural areas and industries; on the other hand, local talents are more likely to form a sense of identity and belonging to the region. They are more inclined to develop and serve the region for a long time, avoiding development obstacles caused by brain drain^[3-5]. Local talents can deeply understand the local needs and problems, and are more willing to actively participate in local community management, ecological environment protection, and other work, creating favorable conditions for the sustained economic growth of the region based on social balance and green development.

3. Existing problems in cultivating higher education talents, adapting to the needs of regional economic development

3.1. Disconnection between talent training goals and regional industrial positioning

Higher education is prone to disconnect from the actual needs of regional economic development in terms of talent training goals. Many schools adopt the traditional discipline-oriented method when formulating training plans, focusing on the improvement and completeness of the systematic discipline knowledge content, without considering the local industrial structure and industry development status^[6]. This unscientific goal setting leads to the knowledge structure and skill content of the trained talents no longer meeting the needs of the local mainstream and emerging industries. For example, some local governments emphasize the development of emerging industrial development, new energy development, ecological technology development, etc., while the corresponding curriculum goals set by schools still stay at the level of old production and application technologies, failing to timely change the technical concepts of industry development. In addition, some universities have not in-depth studied the local development strategy, resulting in their training goals lagging

behind industrial upgrading changes, thus leading to a “time lag” between the supply and demand of graduates, affecting the development of industries in this region, and also causing contradictions in the employment structure of college graduates^[7].

3.2. Low matching degree between the curriculum system setting and actual industrial needs

The curriculum system is the core carrier of talent training, and the degree of matching with regional economic development needs directly reflects the quality of higher education^[8]. Currently, the curriculum systems of some universities have problems, such as outdated and rigid teaching content and inflexible teaching structure. In terms of teaching content, it still focuses on traditional theories and basic concepts, lacking new content such as new technologies and processes, and new standards, resulting in students’ learned knowledge being unable to meet the existing work requirements. In terms of curriculum structure, the proportion of compulsory courses is too high, the types of elective courses are few and weakly connected with industries, and students cannot establish personalized learning structures according to the requirements of local economic development^[9]. In addition, the interdisciplinary integration of curriculum settings is insufficient. For the increasing demand for compound positions in the region, it is impossible to realize the integrated training of multi-disciplinary knowledge through the optimization of the curriculum system. Such a configured teaching curriculum makes students need to spend a lot of time receiving pre-job training after employment to complete work tasks, which will generate additional employment costs for enterprises and reduce the timeliness of university talent training^[10].

3.3. Insufficient operational effectiveness of the school-enterprise collaborative education mechanism

Although school-enterprise joint training is an important means to realize the in-depth integration of higher education and regional economy, its specific effectiveness still has many deficiencies^[11]. First, school-enterprise cooperation is still mainly in relatively shallow and single forms, generally adopting forms such as students’ internships in enterprises and university professors inviting enterprise engineers to give lectures. However, there is a lack of in-depth joint talent training in aspects such as the formulation of students’ talent training programs, curriculum settings, practical training, and scientific research; second, enterprises have low participation, regarding this cooperation as an additional task rather than an opportunity to obtain real benefits. Enterprises’ professional technical forces and job needs are rarely effectively integrated into various links of talent training; third, there is a lack of medium and long-term cooperation mechanisms and interest distribution mechanisms between schools and enterprises. Differences in understanding of cooperation goals, responsibilities, resources, etc., affect the long-term operation of projects; fourth, the policy guidance and support from the government to promote the joint construction of schools and enterprises need to be strengthened. The lack of positive and effective incentives and protection measures cannot fully stimulate the enthusiasm of both parties, leading to difficulties in forming a strong connection in school-enterprise joint training, and failing to play a practical and important role in cultivating talents needed for regional economic development^[12].

4. Countermeasures for cultivating higher education talents adapting to the needs of regional economic development

As China’s regional economy has shown new trends of diversified and characteristic development, the special

function of higher education in talent supply determines that the adaptability of the applied higher education model to regional economic needs will directly determine and affect the specific implementation of regional economic industrial upgrading, innovation-driven, and high-quality development. Currently, phenomena such as the mismatch between the selection of higher education talents and the industrial structure, and the inconsistency between talent skills and social needs in the development of higher education in some regions urgently need to be fully resolved, and a talent training framework that responds to the regional economy should be constructed. The following suggestions will be put forward to more effectively give play to the role of higher education in supporting regional economic development around four main paths.

4.1. Dynamically adjust professional layout and construct a discipline system adapting to the regional industrial structure

A professional setting is the “first pass” for higher education to connect with regional economic needs, so a professional setting also needs to break the original disciplinary boundaries and form a dynamic adjustment mechanism based on the development trend of local industry^[13]. First, at the university level, it is necessary to strengthen cooperation and exchanges with local governments and enterprises, regularly collect information related to local industrial talent needs, and accurately grasp the types and levels of talents in local industries, cutting-edge technology industries, and undeveloped industries; second, establish a reverse chain of “industrial development - talent training - professional setting.” The main industries highlighted and prioritized in the local economic development strategy become one of the goals of university professional directions to avoid a blind professional setting and excessive similarity. For regions mainly relying on traditional industries, it is necessary to promote the modern transformation of traditional industries and the application of intelligent technologies, such as artificial intelligence, to form cross-border compound professional talents. For regions mainly with strategic new industries, it is necessary to accelerate the development of related industries such as artificial intelligence, pharmaceutical biology, clean energy, and new energy materials, and make preparations for talents in future technological innovation industries; for regions with special industries such as tourism health care and nursing industry, it is necessary to strengthen the integration between humanities, sociology, and applied disciplines to produce professional talents adapting to local cultural and industrial development needs; third, increase the intensity of interdisciplinary integration and collaborative integration of different disciplines and majors to achieve in-depth professionalization across borders. Generally speaking, high-level development often requires cross-industry innovative talents. Therefore, universities need to break the barriers between departments, encouraging people in various disciplinary fields to establish alliance-based interdisciplinary curriculum groups or mixed majors, such as “information technology and intelligent production,” “environmental research and renewable energy,” “economics and data analysis,” to cultivate compound talents who can solve complex problems in specific industry fields and provide intellectual support for the cross-border integration of regional industries^[14].

4.2. Strengthen the construction of “Double-qualified” teachers’ teams and enhance the practical orientation of talent training

Teachers’ theoretical knowledge and practical work experience have an important impact on students’ growth. Therefore, to meet the needs of regional economic and social development, it is necessary to build a “double-qualified” teachers’ team with good theoretical professional knowledge and practical work experience. First,

standardize the definition and training mechanism of “double-qualified” teachers, clarify specific requirements in terms of industry experience, scientific and technological research and development experience, and enterprise project practical experience, as assessment indicators for teacher recruitment or evaluation, and encourage teachers to actively engage in industry practice; second, broaden the resource channels for “double-qualified” educators. On the one hand, universities should establish a human resource exchange platform with local enterprises and scientific research institutes, transforming technical personnel or industry elites of these enterprises into part-time teachers or enterprise practice mentors of the university, bringing the latest technical trends, development trends, and practical projects into school courses to make up for the shortage of practical experience of university teachers; on the other hand, universities should also encourage teachers to conduct practical learning in enterprises, such as establishing teacher enterprise practice teaching bases, selecting some teachers to go deep into enterprises to participate in product research and development and technical tackling, so that they can update their knowledge structure and improve their practical ability in the process of practice.

In addition, they can also fund them to participate in industry enterprise qualification certification training to obtain professional qualification certificates corresponding to their majors and enhance the practicality of education; third, strengthen the continuous training and development of teachers’ teams. Create a regular teacher learning mechanism, allowing them to participate in regional economic conferences and technological reform seminars to timely grasp the changing trends of regional economic development and the latest trends of technological development. Co-build personalized curriculum systems with enterprises, and provide targeted professional and technical skill improvement paths for teachers according to the development needs of local mainstream industrial technologies to ensure that teachers’ teaching content can keep pace with the times. Adopt various paths such as “new knowledge learning, going out for exchange, and in-depth practice” to build a professional teacher’ team that can meet the needs of regional industrial development and guide students’ development ^[15].

4.3. Deepen industry-education integration and collaborative education and build a practical platform for talent supply and demand connection

Industry-education integration means the integration of production, teaching, research, and application. It is a teaching method combining theoretical training and production application, an effective way to solve the employment problem of college students, and an inevitable choice for higher education to serve regional economy. Universities should go beyond the previous educational boundaries, take the initiative to integrate into local enterprises, government units, and industry institutions, and jointly establish a university school-running system combining “production, teaching, research, and application”. First, form a stable and long-term school-enterprise joint construction mechanism, such as jointly signing long-term cooperation agreements, establishing school-enterprise joint construction units such as industrial colleges, training bases, or research centers, to realize the optimal complementarity of educational resources and industrial resources. In the process of talent training, give full play to the main role of enterprises, and implement various talent training methods such as “order-based education”, “modern apprenticeship system”, and “practical training”. Enterprises need to participate in the formulation of education plans, the planning of education projects, experimental education practice, student evaluation, etc., and customize training standards according to their own enterprise employment requirements. During their study at school, students can be exposed to a real employment environment and learn professional skills, so that students can quickly meet the enterprise’s requirements for practitioners, thereby reducing the

“preparatory time” for talent training.

In addition, schools can also transform enterprises’ processing and production tasks and research projects into students’ practical activities and graduation thesis research directions, guiding students to learn to research and solve problems in practice. In addition, further promote the integration of production, teaching, and research, build and share innovation platforms, and carry out joint research on major scientific and technological problems encountered in regional economic development. On the one hand, it helps enterprises solve problems; on the other hand, it provides practical carriers for teachers and students to carry out scientific research experiments. Through the in-depth integration of production, teaching, and research, improve the pertinence and effectiveness of talent training, and at the same time make the scientific research achievements in universities take root and benefit local development, realizing the effective connection of the education chain, talent chain with the industrial chain and innovation chain, and building a virtuous cycle of “talent training → economic development → technological innovation.”

5. Conclusion

In summary, cultivating college students adapting to regional economic development is a large-scale, systematic project, which is closely related to regional competitiveness and long-term social development. Plagued by problems such as the mismatch between talent training and industry needs, higher education needs to break through the limitations of fixed models and achieve synchronization with the regional economy through flexible professional reform, specialized teaching teams, and vocational part-time education. Only by integrating university classrooms into the overall situation of regional economic and social development and forming a virtuous cycle of “education → talents → industry → innovation and entrepreneurship” can higher education truly become the fundamental driving force for promoting high-quality development of the regional economy.

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Constructing a “Cross-Border Integration” Innovative Talent Training Model: Reflections Based on the Training of Master’s Students in Energy and Power Engineering

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Abstract: Against the background of the global energy revolution and industrial transformation and upgrading, the demand for innovative talents in the energy and power field presents distinct characteristics of comprehensiveness and cross-border integration. The traditional master’s student training model centered on a single discipline can no longer meet the diverse requirements of the industry for talents’ knowledge structure, thinking mode, and practical ability. By deeply exploring the construction logic of the “cross-border integration” innovative talent training model, analyzing the limitations existing in the current training of master’s students in energy and power engineering, elaborating on the core dimensions of the cross-border integration training model, and proposing specific practical paths, this paper aims to provide ideas for improving the innovation ability and industry adaptability of master’s students in energy and power engineering, and help cultivate comprehensive innovative talents who can address complex energy issues and promote high-quality industrial development.

Keywords: Energy and power engineering; Master’s students; Cross-border integration; Innovative talents; Training model

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1. Introduction

Currently, the world is experiencing a global energy revolution centered on clean energy substitution, efficient energy utilization, and intelligent energy systems. The development trend of cross-penetration between the traditional energy and power engineering industry and new energy technology, information technology, materials science, management science and other disciplines is prominent ^[1]. It not only leads and promotes

the transformation and revolution of the industrial pattern in the energy and power industry but also puts forward new requirements for the capabilities and qualities of engineering professionals in the energy and power industry. Cultivating a large number of applied professionals with multi-field knowledge reserves, interdisciplinary thinking ability, and innovative practical ability is the key to solving the bottlenecks and systematic problems faced by the transformation and development of the energy and power industry. Therefore, breaking disciplinary barriers, promoting the cross-integration of multiple disciplines, and constructing an innovative engineering talent training model that meets the requirements of the times have become an inevitable path for reforming the talent training model of master's students in energy and power engineering. "Cross-border integration" is not a mechanical "addition of knowledge", but an organic integration of knowledge, thinking, methods, and resources from different disciplines guided by problems and centered on ability training, constructing a positive interactive relationship of an interdisciplinary innovative ecology^[2].

2. Core dimensions of the "Cross-Border Integration" innovative talent training model

2.1. Knowledge dimension: Constructing an interdisciplinary knowledge system

Knowledge innovation is the foundation of innovation ability, and interdisciplinary innovation first requires students to have a complete interdisciplinary knowledge structure. The interdisciplinary knowledge structure of master's students in energy and power engineering should take the core discipline knowledge of the energy and power major as the core, supplement the core knowledge of related disciplines, and form a reasonable and hierarchical knowledge system by sorting out the core and supplementary knowledge. Core discipline knowledge is the professional foundation for students to engage in the energy and power industry. It requires students to have solid basic knowledge in the principles of the energy and power field, energy conversion and utilization technology, power machinery design and control, etc., serving as the foundation for the learning and application of interdisciplinary knowledge. Supplementary discipline knowledge should be centered on new energy technology, information technology, materials science, environmental science, management science and other fields, combined with the existing problems and development needs of the core knowledge of the energy and power major^[3]. Knowledge in the field of new energy technology provides students with the principles, technologies, and development trends of the development and utilization of new energy such as solar energy, wind energy, hydropower, and nuclear energy; knowledge in the field of information technology prepares students for the learning of a large number of data analysis, artificial intelligence, Internet of Things and other technologies required by the intelligent and digital needs of energy systems; knowledge in the field of materials science prepares students to understand the performance and application of new energy materials and power machinery materials; knowledge in the field of environmental science cultivates students' awareness of environmental protection and improves their ability to develop low-carbon, pollution-free, and low-emission energy and power technologies; knowledge in the field of management science cultivates students' project management and resource optimization capabilities to meet the diverse demands of the future development of energy enterprises^[4].

2.2. Thinking dimension: Cultivating cross-border innovative thinking

Cross-border innovative thinking refers to the ability to break disciplinary thinking stereotypes and analyze and solve problems with multi-disciplinary thinking, mainly including systematic thinking, critical thinking,

and creative thinking^[5]. Systematic thinking requires students to regard energy and power issues as an overall complex system, starting from the whole, considering the interaction and connection between various components in the system, and analyzing and solving problems using systematic scientific thinking methods. Energy and power itself is a complex, comprehensive system, from multiple links such as energy production, transmission, conversion, and utilization to the related environment, economy, society, etc., all of which are complex complexes that require careful consideration from multiple parties. Cultivating students' systematic thinking enables them to judge energy issues from an overall perspective and formulate scientific and reasonable solutions. Critical thinking refers to the ability to think independently, question, reflect on inherent knowledge, viewpoints, and methods, not follow authority, and discover problems or deficiencies. In the context of cross-border integration, the knowledge and methods of various disciplines are different and even have certain conflicts. Therefore, cultivating students' critical thinking enables them to scientifically distinguish the advantages and disadvantages of knowledge from different disciplines in the learning and research process, learn from and apply them, and avoid blind application^[6].

2.3. Ability dimension: Enhancing cross-border practical and collaborative capabilities

Ability is an intuitive reflection of innovation, and the foothold of the cross-border integration training model lies in improving students' cross-border practical and collaborative capabilities. In addition to solid interdisciplinary knowledge and innovative thinking ability, master's students in energy and power engineering should also have the ability to apply them to practical work, solve practical problems, and cross-border collaborative capabilities to meet the team cooperation needs for carrying out interdisciplinary research and project development. Cross-border practical ability refers to the ability to apply cross-border knowledge and methods to solve practical problems, including practical operation ability, problem analysis and solving ability, technological research and development ability, etc. In the training of master's students, attention should be paid to allowing students to come into contact with practical problems in the energy and power field through practical links, guiding students to apply multi-disciplinary knowledge to analyze the source of problems, formulate solutions to problems, and verify the feasibility of the solutions through practical operations; encourage students to participate in cross-border technological research and development, and exercise technological research and development, innovative practice and other abilities in the research and development process^[7].

3. Construction paths of the “Cross-Border Integration” innovative talent training model

3.1. Optimize the curriculum system to consolidate the foundation of interdisciplinary knowledge

The curriculum system is the basic platform for talent training. To formulate a “cross-border integration” innovative talent training model, it is first necessary to construct a curriculum system, break disciplinary boundaries, and establish an interdisciplinary curriculum system. From the perspective of curriculum setting, the principle of “solid foundation, wide scope, and strong intersection” should be adhered to, the curriculum content structure should be adjusted, and the proportion of interdisciplinary courses should be increased. On the one hand, strengthen the construction of core professional courses to consolidate students' professional foundation. Core professional courses should be adjusted around the development trends and core knowledge needs of the energy and power field, retain classic core knowledge, supplement new ideas, new technologies, new

theories, and new methods, and ensure that students have a solid professional foundation. On the other hand, add interdisciplinary elective courses to expand students' knowledge scope. According to the cross-integration direction of the energy and power field, offer interdisciplinary elective courses such as new energy technology, information technology application, fundamentals of materials science, introduction to environmental engineering, energy economy and management, for students to choose independently according to their professional interests and development needs, and construct their personalized interdisciplinary knowledge structure. Pay attention to the organic connection between courses and offer interdisciplinary comprehensive courses. Interdisciplinary comprehensive courses are problem-oriented around the existing problems in the energy and power field, based on the knowledge and methods of multiple disciplines, guiding students to analyze problems and solve practical problems using knowledge from multiple disciplines. For example, courses such as "Energy System Optimization and Sustainable Development" and "Intelligent Energy and Power System Design" can be offered. In the process of course learning, students can truly feel the integration and application of interdisciplinary knowledge, and improve their ability to apply interdisciplinary knowledge^[8].

3.2. Innovate teaching methods to cultivate cross-border innovative thinking

Teaching reform is the key to stimulating students' cross-border innovative thinking. The traditional classroom lecture-based teaching should be changed, and diversified teaching methods should be implemented to stimulate students' enthusiasm and initiative in active learning and innovation. Implement problem-oriented teaching methods, using typical problems or hot and focal issues related to the energy and power field as materials, allowing students to learn and explore around the problems. In the entire teaching activity, teachers put forward problems with a wide range of involvement and a large disciplinary span. Under the guidance of teachers' problems, students need to find and learn relevant professional knowledge and materials independently, put forward different solutions to the problems, and participate in discussions through classroom teacher-student discussions and group reports^[9]. This method can improve students' enthusiasm for exploring problems, and train and cultivate their ability to analyze and solve practical problems, innovative thinking ability, and expression ability. Implement project-based teaching methods, integrate interdisciplinary projects into teaching, let students form project teams, and conduct research and discussion and practical operation of an interdisciplinary project. In the process of project research, students need to comprehensively apply knowledge from multiple disciplines and carry out team cooperation through different divisions of labor, cooperation, and communication to complete the project, to achieve the goal of cultivating students' cross-border innovative thinking, practical ability, and collaborative ability^[10]. Project topics can be combined with the innovative needs of the energy and power field in technological development, such as "Design Optimization of New Energy Vehicle Power Systems" and "Research on Energy-Saving Control Methods for Smart Grids". In the process of completing the projects, students' knowledge integration ability and innovation ability are exercised and cultivated^[11].

3.3. Improve scientific research training to enhance cross-border practical capabilities

Scientific training is an inevitable path for cultivating master's students and an important channel for improving their cross-border practical capabilities. The scientific training model should be improved to provide graduate students with more opportunities for interdisciplinary scientific research and practical training. Establish an interdisciplinary scientific research project participation model, encouraging graduate students to participate in

interdisciplinary scientific research projects led by supervisors, or organize and form interdisciplinary scientific research project teams to apply for scientific research projects^[12]. Participating in interdisciplinary scientific research project training helps graduate students gain a deeper understanding and mastery of the development process and methods of interdisciplinary scientific research, master the application of multi-disciplinary knowledge to solve specific problems in scientific research and practical activities, and effectively improve their scientific research and innovative practical capabilities. At the same time, supervisors should strengthen the process guidance of interdisciplinary scientific research for graduate students, help and guide them to master interdisciplinary scientific research ideas and methods, and solve problems and difficulties encountered in scientific research. Build an interdisciplinary scientific research and practical platform, coordinate and integrate high-quality scientific research resources inside and outside the university, and establish interdisciplinary laboratories, research centers, and industry-university-research joint bases. The platform should be equipped with interdisciplinary scientific research equipment and resources to provide hardware platform support for graduate students to participate in interdisciplinary scientific research and practice, promote scientific research cooperation between supervisors from different disciplines, form scientific research teams from different disciplines to carry out cooperation, provide graduate students with scientific research guidance from different disciplines, and provide interdisciplinary scientific research and practical training. For example, establish an interdisciplinary research center for energy and the environment, an intelligent energy and power system laboratory, etc., and carry out interdisciplinary experimental research and technology development work on the platform^[13].

3.4. Strengthen the teacher team construction to build a cross-border education team

The teacher team is the basic guarantee for the realization of the “cross-border integration” innovative talent training model. Only with an interdisciplinary education team can the goal of cross-border education be guaranteed. Therefore, it is necessary to strengthen the construction of the teacher team and build a reasonable and high-quality “cross-border” education team. First, increase the cross-border training intensity of the existing teacher team in the discipline. Promote academic exchanges and training of existing teachers, engage in interdisciplinary research in other disciplines, expand the interdisciplinary knowledge structure of existing teachers, and improve their teaching and scientific research capabilities in interdisciplinary education. For example, arrange existing teachers to further their studies in other disciplines, participate in interdisciplinary scientific research projects in other disciplines, and attend interdisciplinary education and teaching training courses, enabling existing teachers to accumulate practical capabilities in interdisciplinary education^[14]. Second, introduce outstanding talents with interdisciplinary backgrounds. Formulate flexible policies for introducing outstanding talents, recruit doctors, postdoctoral fellows with cross-border backgrounds in energy and power engineering or other related disciplines, or outstanding talents with industry backgrounds to join the teacher team, improving the disciplinary structure of the teacher team. On the other hand, invite senior experts with industry backgrounds and rich cross-border practical experience to join the teacher team as part-time supervisors to guide graduate students’ teaching and scientific research work, enabling graduate students to obtain cutting-edge, cross-field, and cross-industry practical experience. Third, build a cross-border teacher synergy, encouraging teachers with interdisciplinary backgrounds to form teaching teams and scientific research teams to carry out interdisciplinary curriculum teaching, scientific research project tackling, and joint training of graduate students^[15].

4. Conclusion

Facing the demand for cross-border integration development in the energy and power field, constructing a “cross-border integration” innovative talent training model is an objective need for the master’s education of energy and power majors to comply with the industry development trend and improve the talent supply level. The “cross-border integration” innovative talent training model is based on the construction of “cross-border knowledge,” centered on the cultivation of “cross-border innovation” thinking, and aimed at the improvement of “cross-border practice” and “cross-border collaboration” capabilities. By optimizing the curriculum structure, innovating teaching methods, carrying out scientific research training, and strengthening teacher training, it realizes the mutual integration of different knowledge, ideas, methods, and resources, and constructs a good ecosystem of collaborative education. The establishment of the “cross-border integration” innovative talent training model is a long-term exploration and cultivation process. In this process, education managers, teachers, and students must work together to break the constraints of traditional educational concepts and institutional systems, continuously explore cross-border integration paths and methods suitable for the training of master’s students in energy and power engineering in practice, and continuously improve the training model in combination with the development needs and talent demands of the energy and power field.

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Research on AI-Enabled Foreign Language Classroom Teaching Model in Higher Vocational Colleges: Innovation of Classroom Teaching Model for Business English Major in Guangzhou South China Business Vocational College

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Abstract: With the rapid development of artificial intelligence technology, its deep integration with the field of education is reshaping traditional teaching models. As a highly application-oriented interdisciplinary discipline, Business English generally faces problems such as low student participation, single teaching methods, and insufficient classroom interaction in its classroom teaching. At the same time, it confronts the challenge of synergistically improving language skills, practical business capabilities, and cross-cultural communication skills. Therefore, leveraging artificial intelligence technology to promote systematic innovation in teaching models has become an urgent priority. Taking the Business English major of Guangzhou South China Business Vocational College as an example, combined with the application practice of the “Teaching Intelligent Language Learning System,” this study explores how AI technology can empower Business English classroom teaching, and systematically constructs a new AI-enabled foreign language classroom teaching model characterized by human-machine collaboration, precision, and efficiency. It provides theoretical references and practical paths for the reform of Business English teaching, and promotes the evolution of foreign language education towards personalization, efficiency, and intelligence.

Keywords: AI; Foreign language classroom; Business English; Teaching model

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1. Introduction

Currently, the in-depth restructuring of the global industrial chain and value chain has placed higher demands on international business talents ^[1]. The talent training goal of the Business English major is transforming from single language ability imparting to comprehensive ability construction ^[2]. Talents in the new era need to simultaneously possess solid English application ability, systematic international business knowledge, agile

cross-cultural communication ability, and practical literacy to face real business environments. However, traditional Business English classrooms are still constrained by multiple structural contradictions: in teaching organization, “emphasizing knowledge infusion while neglecting ability construction”; in resource allocation, “imbalance between homogenized supply and personalized needs”; in practical links, “single simulated scenarios and insufficient authenticity of business situations”; and in feedback mechanisms, prominent problems such as “long cycle and low accuracy”^[3]. These contradictions not only restrict the improvement of teaching effects but also highlight the limitations of traditional teaching models in adapting to the talent training needs of the new era.

In March 2025, the Ministry of Education clearly proposed to “promote the integration of artificial intelligence technology into all elements and the entire process of education and teaching” at the “Artificial Intelligence and Education Reform” deployment meeting, marking that the integration of AI and education has entered a new stage of systematic reshaping from the stage of instrumental application^[4]. Looking at the research history, the application of AI in foreign language teaching has experienced a transformation from initial exploration of computer-assisted language learning, to personalized evaluation supported by intelligent teaching systems, and then to the current “human-machine collaboration” paradigm driven by generative AI represented by large models. Although existing research has made significant progress in the application of technologies such as intelligent speech evaluation and AI writing revision, most of them remain at the level of “single-point empowerment,” lacking systematic restructuring of all elements and the entire process of the teaching model. How to go beyond fragmented tool application and construct a new classroom model centered on learners with AI deeply integrated into the teaching closed loop has become a core problem to be solved in the current reform of Business English teaching.

2. Problems existing in AI-enabled foreign language classroom teaching

Despite the new possibilities brought by AI technology to foreign language teaching, in the teaching practice of the Business English major, AI empowerment still faces prominent problems in the following four aspects.

2.1. Two sides of technology and teaching, insufficient in-depth integration

Most current AI teaching applications still remain at the superficial stage of “technology for technology’s sake,” failing to form organic integration with the core links of Business English teaching. Taking the “Intelligent Language Learning System” widely used in our college as an example, the system performs well in daily oral training, but the proportion of content related to professional scenarios such as “business negotiation,” “exhibition communication,” and “cross-border marketing planning” in its dialogue scenario library is less than 20%, and the complexity and authenticity of scenario design are far lower than the actual business environment. In the process of use, most teachers only use it for basic pronunciation correction and simple dialogue practice. Nearly 70% of teachers admit to only using the follow-up and scoring functions of the system, while the usage rate of its in-built in-depth functions, such as “learning path analysis” and “weakness identification,” is less than 30%. This disconnection between technology and teaching makes it difficult for AI to truly serve the cultivation of core professional abilities such as business negotiation and cross-border marketing planning^[5].

2.2. Convergent functions of intelligent products, lack of professional adaptability

AI language learning products on the market generally have a serious homogenization phenomenon. Through functional analysis of 10 mainstream AI English learning products such as “Lingji Language Teaching System” and “Kouyu Xia” (Oral English Partner), it is found that their core functions are mainly concentrated in general

fields such as vocabulary memory, grammar correction, and basic conversation, while the proportion of characteristic functions targeting the needs of the Business English major is less than 30%. Taking the “Teaching System” as an example, its business terminology database is updated lagging behind, lacking terms in emerging fields such as “blockchain” and “cross-border e-commerce independent stations”; its practical case library mostly consists of fictional scenarios, lacking practical materials from real environments such as the Canton Fair and cross-border e-commerce parks. In simulated international trade negotiations, the system is difficult to identify communication differences under different cultural backgrounds. For example, in Sino-US business negotiation scenarios, it cannot provide effective feedback on the cultural dislocation between students’ direct communication and the indirect communication expected by the US side^[6].

2.3. Lack of human-machine collaboration mechanism, ambiguous role orientation of teachers and students

In the teaching environment with in-depth AI intervention, the role boundaries and collaborative relationships among teachers, students, and AI have not been clearly defined^[7]. Classroom observations on the use of the “Teaching System” in our college found that about 40% of teachers over-rely on the AI system, completely handing over classroom leadership to automatic scoring and path recommendation of the system, ignoring the unique teaching wisdom and contextual guidance of teachers. At the same time, nearly 50% of students stated that when using the system for oral practice, they “pay more attention to the scores of immediate feedback rather than the language logic or business etiquette behind the mistakes”. More notably, there is currently a lack of effective human-machine collaborative teaching models, making it difficult to achieve effective complementarity between teachers’ emotional guidance, creative thinking cultivation, and AI’s technical advantages.

2.4. Single evaluation system, difficulty in measuring comprehensive ability improvement

The evaluation mechanisms of existing AI teaching systems have an obvious tendency of “emphasizing three aspects while neglecting three others”. Taking the current evaluation system of the “Teaching System” used in our college as an example, its evaluation is mostly limited to easily quantifiable basic indicators such as vocabulary accuracy (accounting for 40%) and grammar correctness (accounting for 35%), while the weight of higher-order literacy crucial to the Business English major, such as cross-cultural communication ability (accounting for 15%) and practical business ability (accounting for 10%), is too low^[8]. Among some surveyed AI teaching platforms, only a few have simple business scenario evaluation modules with single evaluation dimensions. For example, when simulating “international procurement negotiations,” the system only focuses on whether the language form is correct, but cannot evaluate key business literacy, such as students’ negotiation strategies and interest coordination abilities.

3. Countermeasures for AI-enabled foreign language classroom teaching

In response to the aforementioned problems, this study puts forward the following countermeasures and suggestions to promote the in-depth integration of AI technology and Business English teaching.

3.1. Construct a “Teaching-Technology” dual-driven model to achieve in-depth integrated development

Establish a curriculum development team composed of professional teachers, technical experts, and enterprise representatives. Set up a “Working Group for Optimizing Business English Functions of the Teaching System”,

and jointly design AI teaching plans oriented to the ability requirements of core courses such as International Trade Practice and Cross-Border E-Commerce. For example, cooperate with the Guangzhou Cross-Border E-Commerce Association to import real case data such as “overseas warehouse location negotiations” and “cross-border brand rights protection” into the “Teaching System”, and develop practical simulation training modules. At the same time, construct a teacher AI teaching ability development system, and regularly hold “in-depth application workshops of the Teaching System” to improve teachers’ ability to use AI data analysis functions to identify students’ weak links and adjust teaching strategies ^[9].

3.2. Develop professional intelligent teaching products to improve industry adaptability

Jointly develop professional AI products suitable for Business English teaching with the joint efforts of industry enterprises, technology suppliers, and professional teachers ^[10]. Focus on promoting the upgrading of the “English Professional Teaching System” in the following directions: build a dynamically updated business terminology database, and update terms in emerging fields such as “digital economy” and “green trade” with industry experts every quarter; develop an intelligent writing assistance system with business context recognition capabilities, and embed evaluation models trained based on actual business documents in the “Teaching System” for professional genres such as business reports and foreign trade correspondence; construct a cross-cultural business communication simulation platform, implanting business cultural characteristics and communication taboos of major trading partner countries (such as the United States, Germany, Japan, etc.).

3.3. Establish a “Teacher-AI-Student” ternary collaborative mechanism to clarify the role orientation of all parties

Construct a new teaching community with teachers as the leading role, AI as the auxiliary role, and students as the main body. Pilot the “hierarchical teaching model assisted by the Teaching System” in the International Business Negotiation course of our college: teachers are responsible for core knowledge explanation and higher-order thinking guidance, organizing real negotiation simulations and commenting on students’ strategy choices; the “Teaching System” provides personalized basic training, generating customized terminology exercises and speech training for different students’ problems; students should transform from passive acceptance to active construction under the guidance of teachers and the assistance of AI, and then use the system’s video playback function for self-reflection and peer evaluation ^[11].

3.4. Construct a multi-dimensional intelligent evaluation system to comprehensively measure student development

Break through the limitations of single language knowledge evaluation, and establish a multi-dimensional intelligent evaluation system covering language skills, business literacy, and cross-cultural abilities. Technically, the evaluation module of the “Teaching System” can be upgraded to conduct an in-depth evaluation of students’ comprehensive performance in business scenario simulations using natural language processing technology. For example, in “cross-border e-commerce customer service simulation”, the system not only evaluates language accuracy but also evaluates the appropriateness of customer service speech through sentiment analysis technology and the effectiveness of problem-solving through intent recognition. At the same time, establish a “process evaluation file” to record students’ growth trajectories in different AI teaching scenarios, and generate personal ability development curves through data visualization technology. In addition, introduce enterprise evaluation dimensions, and connect the system to real customer service dialogue data of cross-border e-commerce

enterprises to make teaching evaluation more in line with industry standards^[12].

4. Path for constructing AI-enabled classroom teaching model for the business English major

Based on the aforementioned problem analysis and countermeasure suggestions, this study systematically constructs a “three-layer, four-dimensional, dual-driven” AI-enabled Business English teaching model. Guided by constructivist theory and situational learning theory, with the concept of human-machine collaboration as the core, it aims to create a full-process, personalized, and intelligent smart teaching ecosystem^[13]. The specific implementation paths are as follows (Table 1).

4.1. Construct a three-level curriculum system of “Basic layer - Core layer - Expansion layer”

At the basic layer, rely on the intelligent speech recognition and real-time feedback technology of the “Teaching System” to build a language skill training module, focusing on improving students’ basic English listening, speaking, reading, writing, and translation abilities. At the core layer, use the virtual simulation technology of the “Teaching System” to develop professional course modules such as business negotiation, foreign trade practice, and cross-border marketing. For example, in the Foreign Trade Document Operation course, use the AR technology of the system to simulate the document filling and review process. At the expansion layer, provide expansion courses such as cross-cultural management and international commercial law through the big data analysis of students’ personalized needs by the “Teaching System”, forming a progressive curriculum structure of “basic consolidation-professional deepening-personalized expansion”^[14].

4.2. Establish a Four-Dimensional Teaching Mechanism of “Situation – Interaction – Data - Evaluation”

In the situation dimension, use the “Teaching System” to construct immersive business scenarios, such as intelligently simulating real working environments such as Canton Fair booth negotiations and cross-border video conferences. In the interaction dimension, carry out multi-round, multi-role business communication training through functions such as human-machine dialogue and virtual role interaction of the “Teaching System”, simulating price negotiations with purchasers from different cultural backgrounds. In the data dimension, use the learning analysis technology of the “Teaching System” to record students’ learning behaviors throughout the process, establish personal learning portraits, and real-time track students’ development in dimensions such as “business terminology mastery” and “cross-cultural sensitivity”. In the evaluation dimension, adopt the multi-modal data analysis technology of the “Teaching System” to comprehensively evaluate students’ language expression, business literacy, cross-cultural abilities, etc., forming a closed-loop system of “integration of teaching, learning, and evaluation”.

4.3 Form a “Teacher Wisdom + AI Technology” dual-driven teaching process

Pre-class: Precise diagnosis and adaptive preview. Teachers accurately design teaching objectives and content based on the learning situation analysis report generated by the “Teaching System”; the “Teaching System” pushes personalized preview materials according to individual differences of students, providing terminology explanations for students with weak foundations and case background knowledge for advanced students. In-class: Higher-order thinking and real-time scaffolding. Teachers lead higher-order thinking activities such as project-based and case-based learning, organizing discussions on real business planning schemes; the “Teaching System” provides technical support such as real-time language support and scenario simulation, intelligently

recommending professional expressions when students have difficulty in expression. Post-class: Intelligent consolidation and precise intervention. The “Teaching System” automatically generates personalized exercises, and teachers implement precise tutoring through data analysis, designing special training for links where students generally perform weakly in simulated negotiations.

4.4. Build a “School – Enterprise – Research” Ternary Collaborative Support Platform

Enterprises provide real case libraries and the latest industry standards, schools are responsible for the design and implementation of teaching content, and technology enterprises provide AI platform support and maintenance. Co-build a “Business English AI Teaching Laboratory” with teaching system companies to develop teaching resource libraries in line with professional characteristics; set up “Teaching System Teaching Application Research Projects” to promote the continuous optimization of teaching models; establish a “Teaching System Certified Lecturer” training mechanism, regularly organizing teachers to participate in AI teaching ability improvement training to ensure the effective implementation and dynamic improvement of the teaching model.

4.5. Implement a teaching optimization mechanism of “Diagnosis - Early warning - Intervention”

Establish a teaching quality monitoring system based on the teaching process data collected by the “Teaching System.” Identify prominent problems in the teaching process through intelligent diagnosis; when the system detects that more than 30% of students continue to perform poorly in the “cross-cultural business etiquette” module, it automatically issues an early warning to the teaching team; the teaching team conducts special discussions based on the early warning information to formulate targeted intervention strategies; and verifies the intervention effect through methods such as A/B testing, forming a continuous improvement closed loop of “monitoring-diagnosis-intervention-improvement.”

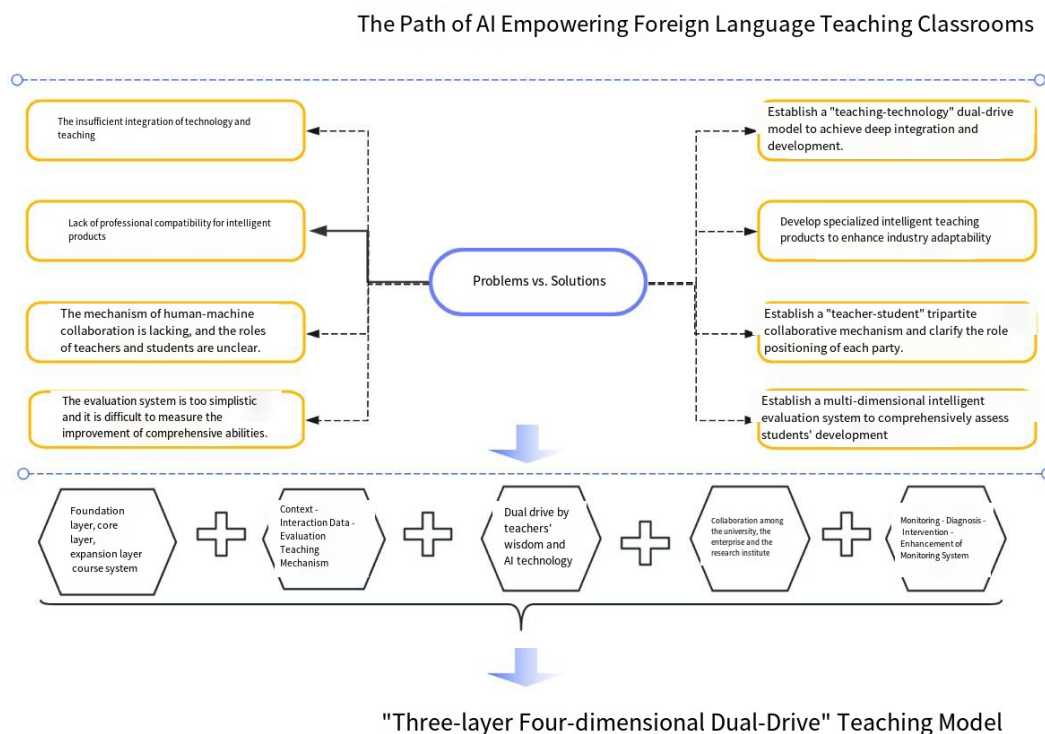


Figure 1. Path of AI-enabled foreign language teaching classroom.

5. Conclusion

The in-depth integration of AI technology and Business English education is reshaping traditional teaching models. By constructing a “three-layer, four-dimensional, dual-driven” teaching model and designing specific implementation paths with the “Intelligent Language Teaching System” as the technical carrier, this study not only provides a systematic solution to the practical dilemmas currently faced by AI-enabled Business English teaching but also depicts a new picture of education featuring human-machine collaboration and intelligent symbiosis^[15].

In the wave of digital transformation, we must clearly recognize that technology is always just a means, and talent cultivation is the fundamental goal. The core of AI empowerment does not lie in the sophistication of technology, but in its return to the essence of teaching, teaching students in accordance with their aptitude, so that every student can receive the most suitable education. The particularity of Business English teaching requires us to take a distinctive path of in-depth integration of technology and professionalism. We must not only give full play to the technical advantages of AI in students’ personalized learning and intelligent evaluation, but also always maintain the leading position and professional judgment of teachers in the teaching process.

In the future, with the continuous evolution of AI technology and the in-depth integration of educational concepts, Business English teaching will pay more attention to human-machine collaboration, data-driven, and personalized development. The “three-layer, four-dimensional, dual-driven” model constructed in this study provides a feasible path for AI-enabled foreign language teaching, but it also needs to be continuously tested and optimized in the continuous collaboration with technical platforms such as the “Teaching System,” ultimately achieving the fundamental goal of cultivating new-era international business talents with a global perspective, professional capabilities, and humanistic feelings.

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Application and Practice of Curriculum Ideological and Political Concepts in the Course “Municipal Road Engineering Construction”

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Abstract: Under the guidance of the spirit of the National Conference on Ideological and Political Work in Colleges and Universities, curriculum ideological and political education has become a key measure to implement the fundamental task of moral education. Taking the course “Municipal Road Engineering Construction” as the research object, this paper explores the path of in-depth integration of curriculum ideological and political concepts with professional teaching. By excavating ideological and political elements such as engineering ethics, craftsmanship spirit, green development, and cultural confidence contained in the course, a trinity teaching system of “knowledge transmission - ability training - value shaping” is constructed. Combined with specific teaching practice cases, the implementation effect of curriculum ideological and political education is analyzed. Research shows that the integration of curriculum, ideological and political education not only improves students’ professional literacy but also strengthens their sense of social responsibility and professional identity, providing an effective paradigm for cultivating high-quality municipal engineering talents with “both moral and technical proficiency”.

Keywords: Curriculum, ideological and political education; Municipal Road Engineering Construction; Engineering ethics; Craftsmanship spirit; Green development

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1. Introduction

1.1. Research background

It was emphasized at the National Conference on Ideological and Political Work in Colleges and Universities that “we must adhere to moral education as the central link, integrate ideological and political work into the entire process of education and teaching, and realize education for all, throughout the whole process, and in all courses.” As an innovation in the talent training model of colleges and universities in the new era, curriculum ideological and political education requires professional courses to break through the limitations of traditional knowledge transmission, organically integrate ideological and political education elements into teaching content,

and form a great ideological and political pattern where “ideological and political courses” and “curriculum ideological and political education” go hand in hand.

“Municipal Road Engineering Construction” is a core course for majors such as Municipal Engineering Technology and Road and Bridge Engineering Technology in higher vocational colleges, featuring strong practicality, high correlation with people’s livelihood, and rapid updates of technical standards. The course not only involves professional knowledge, such as road design, construction technology, and quality control, but also covers social issues, such as engineering safety, environmental protection, and professional norms. Integrating curriculum, ideological and political concepts into teaching can not only help students master professional skills but also guide them to establish correct values, professional views, and a sense of social responsibility, which meets the training requirements for “great power craftsmen” in the new era^[1].

1.2. Research significance

From the perspective of talent training, practitioners in the municipal engineering field need to have solid technical capabilities and a high sense of social responsibility, road engineering is directly related to urban operation safety, residents’ quality of life, and even the sustainable development of the ecological environment. Through curriculum ideological and political education, students can deeply understand the social value of engineering in the process of learning professional knowledge, cultivate a rigorous craftsmanship spirit, a green and low-carbon development concept, and a professional feeling of serving people’s livelihood, delivering “morally and academically outstanding” qualified builders to the industry.

From the perspective of curriculum reform, the current course “Municipal Road Engineering Construction” still has problems, such as insufficient excavation of ideological and political elements and rigid integration methods. This study explores the integration path suitable for professional characteristics by systematically sorting out curriculum ideological and political elements, providing a reference paradigm for the ideological and political construction of similar courses^[2].

2. Theoretical basis of curriculum, ideological and political education and analysis of course characteristics

2.1. Connotation and Goals of Curriculum Ideological and Political Education

Curriculum ideological and political education aims to build an all-staff, whole-process, and all-course great ideological and political education system. It emphasizes excavating ideological and political education resources in professional courses and realizing the educational effect of “moistening things silently” through the organic unity of knowledge transmission, ability training, and value shaping. Its core is to naturally integrate elements such as socialist core values, excellent traditional Chinese culture, and professional ethics into professional teaching, cultivating students’ family and country feelings, sense of social responsibility, and innovative spirit^[3].

2.2. Ideological and political education characteristics of the course “Municipal Road Engineering Construction”

2.2.1. A natural carrier of engineering ethics and social responsibility

Municipal road engineering involves people’s livelihood issues, such as public safety, traffic organization, and residents’ lives. In the construction process, it is necessary to balance technical feasibility and social impact. For example, when explaining “old road reconstruction projects,” students can be guided to think about how

to reduce the impact on surrounding residents by optimizing construction plans, infiltrating the development thought of “people-centered.”

2.2.2. An important platform for cultivating craftsmanship spirit

Links such as surveying and setting out, material proportioning, and process connection in road construction all require precision and meticulousness, allowing no carelessness. For example, in the teaching of “subgrade compaction,” the impact of compaction degree control on road service life can be explained to emphasize the craftsmanship spirit of “details determine success or failure,” and cultivate students’ rigorous work attitude.

2.2.3. A practical field for green development concepts

With the advancement of the “dual carbon” goal, municipal road engineering is developing in the direction of ecologization and intelligence. The application of new technologies such as permeable pavement, recycled material utilization, and intelligent transportation systems can be deeply combined with the concept of “lucid waters and lush mountains are invaluable assets,” guiding students to establish environmental awareness and innovative thinking.

2.2.4. A historical dimension for cultivating cultural confidence

China has made remarkable achievements in ancient road engineering, and in modern times, it has built world-class projects such as the Hong Kong-Zhuhai-Macao Bridge and the transportation hub of Beijing Daxing International Airport. Introducing these cases in teaching can stimulate students’ national pride and enhance cultural confidence.

3. Excavation of curriculum, ideological and political elements and construction of the teaching system

3.1. Systematic sorting of curriculum ideological and political elements

According to the course content modules and combined with the goals of ideological and political education, the following core ideological and political elements are extracted (Table 1).

Table 1. Core ideological and political elements

| Teaching Modules | Professional Knowledge Points | Ideological and Political Elements | Educational Goals |
|-------------------------------|---|--|---|
| Road Engineering Introduction | Functions and classification of municipal roads | Connection between urban development and people’s livelihood | Enhance professional identity and understand the people’s livelihood value of engineering |
| | Development history of road engineering at home and abroad | Comparison of ancient and modern engineering achievements | Cultural confidence and awareness of technological innovation |
| Road Engineering Materials | Characteristics of asphalt, concrete, and other materials | Material performance and environmental protection requirements | Green development concept and circular economy awareness |
| | R&D and application of new materials | Independent innovation cases | Spirit of serving the country through science and technology, and craftsmanship spirit |
| Road Subgrade Construction | Selection of subgrade filling materials and compaction technology | Quality control and engineering safety | Sense of responsibility and rigorous scientific attitude |

Table 1 (Continued)

| Teaching Modules | Professional Knowledge Points | Ideological and Political Elements | Educational Goals |
|--|---|--|---|
| Pavement Engineering Construction | Soft soil foundation treatment | Balance between the economy and the sociality of technical schemes | Engineering ethics and the purpose of serving people's livelihood |
| | Construction technology of asphalt pavement | Standardization and refinement of construction processes | Craftsmanship spirit and standardized operation awareness |
| | Permeable pavement and sponge city technology | Ecological environmental protection and sustainable development | Green and low-carbon concept and innovative thinking |
| Construction Organization and Management | Construction period arrangement and resource allocation | Teamwork and cost awareness | Spirit of collaboration, awareness of conservation, and professional ethics |
| | Construction safety and civilized construction | Safety norms and social responsibility | Concept of life first and awareness of civilized construction |

3.2. Construction of the “Trinity” teaching system

3.2.1. Theoretical teaching: Combination of implicit penetration and explicit guidance

When explaining professional knowledge, ideological and political elements are implicitly penetrated through case introduction and problem discussion. For example, in the chapter “History of Road Development”, compare the “standardized construction” of the Qinzhi Road with the technological breakthroughs of modern expressways, guiding students to think about the continuity of Chinese civilization and the importance of technological innovation. In “Asphalt Pavement Construction,” introduces China’s independently developed rubber asphalt technology, explaining both technical principles and emphasizing its environmental benefits and circular economy value ^[4]. For content involving engineering ethics, an explicit guidance method is adopted, organizing students to analyze the responsibility issues behind accidents and discuss the professional principle of “safety first.”

3.2.2. Practical teaching: Strengthening professional literacy in practical operation

Practical links are key scenarios for cultivating students’ craftsmanship spirit and sense of responsibility. For example, in the training of “subgrade compaction degree detection,” students are required to operate strictly in accordance with specifications and are not allowed to falsify or perfunctorily record data, cultivating the professional habit of “true data and standardized operation”. In the “construction site simulation” project, a task of “civilized construction management” is set, requiring students to design dust control and noise monitoring schemes, strengthening environmental awareness and social responsibility ^[5].

3.2.3. Course assessment: Integrating ideological and political evaluation dimensions

Reform the traditional assessment method and include ideological and political performance into the evaluation system. For example: in group assignments, add scoring items such as “attitude towards teamwork” and “innovation of environmental protection schemes”; in the final exam, set open-ended questions such as “how to balance progress, quality and environmental protection requirements in road construction” to examine students’ comprehensive values; evaluate students’ sense of responsibility and professional literacy in practice through internship reports and project summaries ^[6].

4. Practical paths and cases of curriculum ideological and political education

4.1. Case teaching method: Taking “Sponge City Road Construction” as an example

4.1.1. Teaching goals

Professional goal: Master the construction key points of sponge city technologies such as permeable pavement and rain gardens; Ideological and political goal: Understand the importance of ecological civilization construction and cultivate green innovative thinking.

4.1.2. Teaching process

First, display a comparative video of the drainage effects of traditional roads and sponge roads, and ask: “Why promote sponge cities? What development concept does this reflect?” Guide students to discuss in combination with the content of “ecological civilization construction” in the 14th Five-Year Plan.

Second, analyze the material proportioning and construction technology of permeable concrete, emphasize its functional characteristics of “infiltration, retention, storage, purification, utilization, and drainage”, introduce concepts such as “zero-waste city” and “circular economy”, and explain the role of technological innovation in promoting environmental protection.

Third, introduce the sponge city road reconstruction project in Haicang District, Xiamen, showing its effects in reducing waterlogging and improving the ecological environment. At the same time, mention the technical difficulties encountered during construction (such as cost control and public cooperation), organize students to discuss solutions in groups, cultivating the ability of “discovering problems - analyzing problems - solving problems.”

Fourth, assign after-class tasks: “Assuming you are the technical director of a sponge road project, how to explain the significance of the project to community residents and gain their support?” Guide students to shift from technical thinking to social communication, strengthening the service awareness of “people-centered.”

4.1.3. Highlights of ideological and political integration

Through the combination of technology and policies, abstract concepts such as “green development” and “technological innovation” are transformed into perceptible engineering practices; using social contradictions in real cases, guide students to think about the social attributes of engineering, and cultivate communication skills and a sense of responsibility^[7].

4.2. Project-based learning: Practice of “Campus Road Optimization Design”

4.2.1. Project background

Taking a section of damaged road on campus as the object, students are required to complete the whole process tasks of “detection and evaluation - scheme design - construction organization - cost accounting” in groups, while considering the characteristics of campus traffic and environmental protection requirements.

4.2.2. Key points of ideological and political integration

Teamwork and responsibility division: At the project initiation stage, guide students to clarify the roles and responsibilities of team leader, technical personnel, budget specialist, and presenter, emphasizing the importance of “each performing their duties and cooperating with each other”, cultivating professional collaborative spirit; in the surveying link, require error control at the millimeter level, correcting the mentality of “close enough” through repeated practical operations, strengthening the rigorous attitude of excellence; in the scheme

presentation, set up a “simulated owner review” link, requiring students to explain professional schemes in plain language, focusing on explaining “how to reduce the impact of construction on teaching order”, cultivating service awareness and communication skills; encourage groups to adopt schemes such as recycled aggregates and permeable pavement, and calculate their environmental benefits, transforming the “dual carbon” goal into specific actions^[8].

4.2.3. Implementation effects

Through project practice, students not only mastered professional skills such as road detection, design, and construction organization but also improved in the following aspects: 92% of students believed that “they learned tolerance and responsibility in teamwork”; 85% of students said that “they paid more attention to environmental protection and people’s livelihood factors when solving practical problems”; the project results were adopted by the school and used as practical teaching cases, enhancing students’ sense of achievement and professional identity^[9].

5. Effect analysis and reflection on curriculum ideological and political education

5.1. Effect analysis

5.1.1. Student feedback survey

Through a questionnaire survey (sample size: 200 people) and interviews, it was found that 89% of students recognized the integration method of curriculum ideological and political education, believing that “professional knowledge and ideological and political content are naturally combined without a sense of rigidity”; 78% of students said that “they have a deeper understanding of the social value of municipal engineering”, and their professional identity was significantly improved; 65% of students actively paid attention to environmental protection and safety issues during construction during internships, reflecting the transfer effect of curriculum ideological and political education^[10].

5.1.2. Reflection of teaching achievements

Students won the first prize in the “Municipal Engineering Construction Technology” competition in the provincial vocational skills competition, and the judges commented that their “scheme design has both technicality and social responsibility”; the “curriculum ideological and political case library for municipal road construction” developed by the course team was listed as a school-level high-quality resource for reference by other majors; relevant teaching reform achievements were exchanged at the national seminar on municipal engineering teaching in higher vocational colleges and were affirmed by peers^[11].

5.2. Existing problems and improvement directions

5.2.1. Problem analysis

Insufficient depth in the excavation of ideological and political elements: Some teaching links still stay at the level of case enumeration, failing to fully combine the philosophical connotation of the course; professional teachers lack systematic mastery of ideological and political theories, and have a sense of difficulty when guiding students to discuss values; there is a lack of scientific tools for quantitative evaluation of ideological and political effects, making it difficult to accurately measure changes in students’ values^[12–14].

5.2.2. Improvement measures

Combine theories such as engineering philosophy and ethics to develop a special teaching module of “ethical dilemmas in municipal engineering”, guiding students to think in depth through debates and role-playing; organize special training on curriculum ideological and political education, inviting ideological and political teachers and professional teachers to prepare lessons together to improve interdisciplinary teaching capabilities; introduce the “growth portfolio” evaluation method, track the development of ideological and political literacy through students’ reflection logs, project summaries, and social service records, and explore a collaborative evaluation mechanism with ideological and political teachers ^[15].

6. Conclusion

The practice of curriculum ideological and political education in the course “Municipal Road Engineering Construction” shows that professional education and ideological and political education are not separated, but can achieve “knowledge transmission with temperature and value guidance with strength” through in-depth integration. By excavating elements such as engineering ethics, craftsmanship spirit, and green development contained in the course, combined with diversified methods such as case teaching and project practice, students’ professional abilities and ideological realm can be effectively improved, cultivating high-quality talents with “understanding technology, having feelings, and daring to take responsibility” for the municipal engineering industry.

In the future, it is necessary to further explore the integration path of curriculum ideological and political education with information technology, strengthen school-enterprise-government cooperation, introduce real cases and professional standards from the front line of the industry into the classroom, making curriculum ideological and political education more timely and appealing. At the same time, a cross-curriculum ideological and political education system should be constructed to promote the formation of ideological and political education synergy between “municipal roads” and courses such as “engineering surveying” and “construction regulations,” jointly building a professional ecology for all-round education.

Disclosure statement

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Construction and Practice Exploration of the “Four-Line Mental Health Education” Model in Secondary Vocational Schools

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Abstract: Against the macro background of China’s march towards high-quality development, mental health education for secondary vocational students is facing new challenges and opportunities. Based on the new ecology of collaborative education involving families, schools, and society, this study addresses the current problems in secondary vocational mental health education, such as static early warning mechanisms, insufficient peer support systems, and single-form activities, and proposes and systematically constructs the “Four-Line Mental Health Education” model. This model takes strengthening the early warning and intervention network as the foundation, building a peer support platform as the path, constructing a mental health curriculum system as the support, and creating characteristic practical activities as the strategy. The four lines work in coordination, aiming to provide a systematic, dynamic, and interconnected educational model for mental health education in secondary vocational schools and shape students’ positive psychological qualities and sound personalities.

Keywords: Four-Line Mental Health Education; Secondary vocational schools; Mental health education

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1. Introduction

With the transformation and upgrading of China’s social economy, the demand for high-quality technical and skilled talents is increasingly urgent. As an important cornerstone of the modern vocational education system, the high-quality development of secondary vocational education has been endowed with new connotations of the times. The mental health status of secondary vocational students is not only related to their personal growth and career development but also directly affects the overall quality of the future labor force and social harmony and stability.

At present, secondary vocational mental health education still faces several bottlenecks, mainly manifested in: in terms of psychological early warning and intervention, most existing research and practices focus on single-line and static descriptions, monitoring content concentrates on current situation and cause exploration,

and intervention mechanisms tend to be theoretical discussions, lacking a dynamic and closed-loop operation system, which reduces the predictive role of psychological census data in crisis prevention and intervention ^[1]; in terms of peer support mechanisms, although their effectiveness has been confirmed ^[2], a sound and promotable systematic operation paradigm has not yet been formed; in terms of mental health courses and practical activities, the content and forms are relatively single, and most are student-centered, lacking effective empowerment for teachers and parents, failing to fully reflect the concept of collaborative education. In addition, there are various existing mental health education models in research, such as the full-participation model ^[3], the “one-two-three” model ^[4], the “trinity” model ^[5], the “one center, two wings, and five collaborations” model ^[6], and the “five-linkage and one-center” system ^[7], etc. However, most of these projects are parallel, and their operation lacks overall connectivity, making it difficult to form systematic synergy. Therefore, it is very necessary to integrate resources from families, schools, society, and other parties to form educational synergy and build an all-round, multi-level, and three-dimensional educational model.

2. Theoretical basis and definition of core concepts of the “Four-Line Mental Health Education” model

2.1. Theoretical basis

2.1.1. Positive psychology

This study takes positive psychology as the core theory, aiming to move beyond “problem-oriented” to “strength-oriented.” Through constructing curriculum and activity systems, it systematically shapes students’ positive psychological qualities such as optimism, resilience, and gratitude, and promotes the formation of their sound personalities ^[8].

2.1.2. Embodied cognition theory

Psychological growth is not only a mental activity but also needs to be realized through specific practical experiences ^[9]. The strategy of “creating characteristic practical activities” in this study is based on this theory. Through various embodied and contextualized activities, students are allowed to “understand through experience” and internalize psychological knowledge into psychological abilities.

2.1.3. Ecological systems theory

This study considers students within the microsystem and mesosystem composed of schools, families, and society (hospitals). In particular, the design of the early warning and intervention network clearly reflects the idea of tripartite linkage between schools, families, and hospitals, aiming to build a stable and supportive external growth environment for students ^[10].

2.2. Definition of core concepts

2.2.1. Mental health education model

This study holds that a mental health education model is a relatively stable structural framework, procedure, and method of educational activities adopted to achieve specific educational goals under the guidance of relevant mental health education theories. It is not a simple accumulation of scattered activities but an educational system with internal logic, clear goals, stable structure, and clear procedures.

2.2.2. “Four-Line Mental Health Education” model

The “four lines” in this study refer to strengthening the early warning and intervention network, building a peer support platform, constructing a mental health curriculum system, and creating characteristic practical activities. These four lines do not exist in isolation but form an interdependent and collaborative organic whole.

3. Systematic construction and practice of the “Four-Line Mental Health Education” model

3.1. Construction of the “Four-Line Mental Health Education” service model

The construction of the “Four-Line Mental Health Education” model follows the logical progressive relationship of “foundation-path-support-strategy”, forming a closed-loop system with complete structure and complementary functions, which jointly play the roles of prevention, development, support, and intervention. Its overall structure is shown in **Figure 1** below.

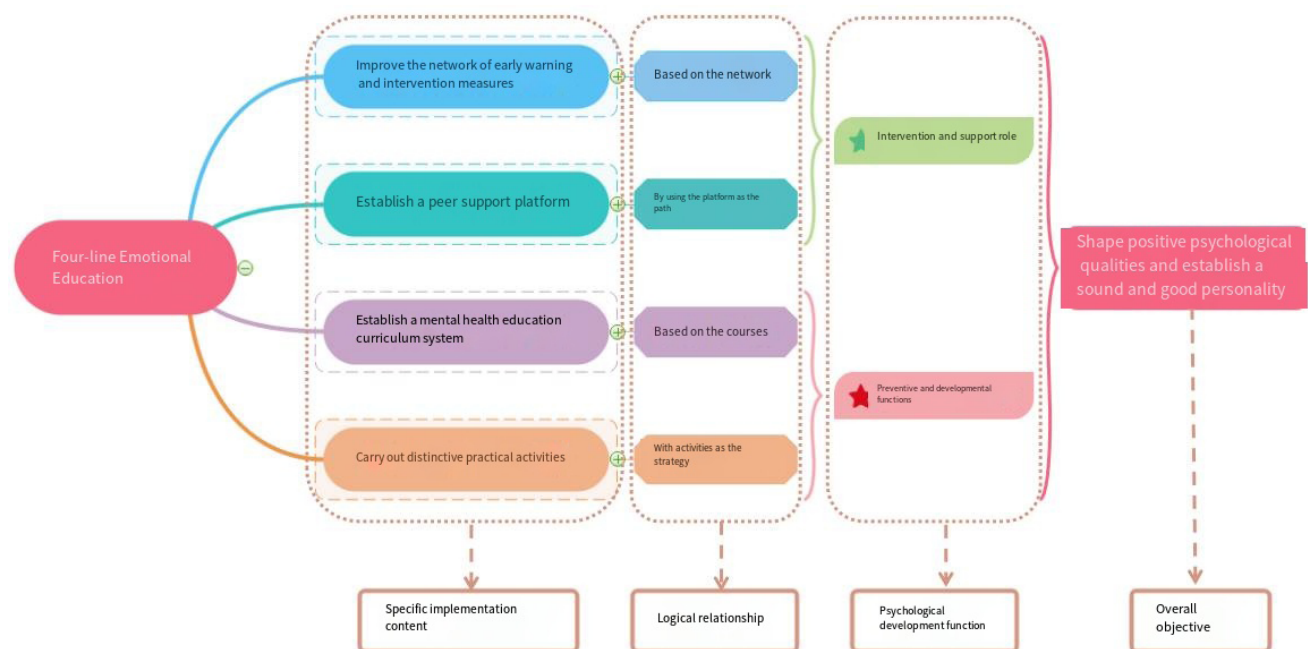


Figure 1. Structure diagram of the “Four-Line Mental Health Education” system.

In this model, the network serves as the foundation, providing a safety bottom line and data support for the entire mental health education work; the platform serves as the path, activating the self-help and mutual assistance energy of the student group; the curriculum serves as the support, providing systematic and scientific knowledge and skill guidance; the activities serve as the strategy, providing experiential learning to nourish the mind. The four lines work together to promote the achievement of the overall goal.

3.2. Practice of the “Four-Line Mental Health Education” service model

3.2.1. First line: Strengthen the early warning and intervention network

The early warning and intervention network is the cornerstone of the entire model. Its core goal is to achieve dynamic monitoring of students’ mental status, early identification of crises, and timely intervention, constructing a closed-loop work system of “screening – assessment – intervention - tracking.”

The core of this system lies in the “two-way monitoring” and “school-family-hospital linkage” early warning and intervention model led by the school. It specifically includes three links:

- (1) Precise psychological census: Conduct regular psychological censuses of students every year, establish a three-level psychological file of “individual-class-grade,” conduct early warning classification screening through data analysis, and realize the transformation from “static description” to “dynamic monitoring.”
- (2) Hierarchical intervention mechanism: Divide early warning levels and activate corresponding intervention plans. Early warning levels can be divided into: Level I early warning, Level II early warning, Level III early warning, and Level IV early warning. For general early warnings, universal interventions such as group counseling and thematic education are adopted; for high-risk early warnings (including Level I, II, and III early warnings), a refined intervention chain with systematic collaboration, such as school-family collaborative intervention, professional medical diagnosis, and individual counseling and intervention, is activated.
- (3) Professional consulting services: Professional psychologists provide continuous one-on-one psychological and behavioral counseling and intervention for students in need to ensure the professionalism and effectiveness of intervention.

3.2.2. Second line: Build a peer support platform

Peer support is an important bridge connecting professional intervention and daily life observation, and an effective path to “decentralize” mental health education and achieve wide coverage^[11]. This model is committed to building an online-offline integrated peer support platform.

- (1) Online platform: Relying on mutual assistance mini-programs or APPs, provide functions such as “popular science knowledge,” “psychological assessment,” and “consultation appointment,” breaking the constraints of time and space, providing students with a convenient and private entry for psychological support, and playing the role of independent mental health maintenance.
- (2) Offline system: Take psychological committee members and dormitory supervisors as the main body of offline peer support, carry out training to empower backbone students to cultivate their support and mutual assistance capabilities, guide dormitory supervisors and psychological committee members to conduct daily observations and regular summary reports, forming a closed-loop of peer support of “discovery-feedback-support”. Studies have shown that the psychological assistance paradigm of peer support is in line with the psychological development characteristics of secondary vocational students. Nanning No.3 Vocational School has greatly improved the psychological quality of secondary vocational students by improving the management mechanism of psychological peer associations^[12], and Shanghai Commercial School has helped secondary vocational students establish self-confidence, learn communication, and develop sound personalities through a series of peer support activities^[13], laying a solid practical foundation for this study.
- (3) Student autonomous management: Encourage students to participate as student assistants in psychological counseling rooms and mental health volunteers, independently plan and carry out various rich and colorful experiential activities, enhance mutual assistance and support among students, achieve self-growth in serving others, and cultivate psychological energy for self-service and self-growth.

3.2.3. Third line: Construct a mental health curriculum system

Curriculum is the fundamental guarantee for the scientization and systematization of mental health education.

Based on the concept of collaborative education, this model constructs a hierarchical and classified curriculum matrix for three groups: students, teachers, and parents^[14].

- (1) Student development curriculum: Establish a three-dimensional system of “compulsory courses + elective courses + grade-specific characteristic courses.” Compulsory courses (such as Mental Health and Career Development) ensure basic coverage; elective courses (such as Interesting Psychological Potential Development, Sunshine Psychology, Cognitive and Behavioral Ability Improvement) meet personalized needs; grade-specific characteristic courses (such as freshman adaptation, adolescent growth and development, interpersonal communication, and pre-college entrance examination stress reduction) accurately align with the characteristics of students at different development stages.
- (2) Teacher mental health education curriculum: Empower all teachers, construct a curriculum system covering modules such as “identification and intervention of psychological crisis cases,” “practice of positive mental health education methods,” and “discussion on common psychological and behavioral problems of students,” improve teachers’ practical abilities, and make them an important force in mental health education.
- (3) Family-school series courses: Promote through dual tracks of family mental health guidance and family-school collaborative education courses, provide parents with guidance on “modern family education concepts,” “parent-child communication skills,” and “identification and response to children’s psychological problems,” improve family education capabilities, and build a family-school psychological education community. Chen Li’s research shows that family-school collaborative education is effective in intervening in the psychological problems of secondary vocational students^[15], which provides strong theoretical support for this study.

3.2.4. Fourth line: Create characteristic practical activities

Practical activities are the “catalyst” for transforming theoretical knowledge into internal qualities and an important carrier for creating a positive campus psychological culture. The innovation, experience, and branding of activities are particularly important.

- (1) Large-scale psychological activities: Taking the Student Mental Health Publicity and Education Month as an opportunity, hold large-scale psychological theme garden parties, set up a series of interesting projects, help students release pressure and enhance team collaboration through gamified experiences, and make it a brand activity of campus psychological culture.
- (2) Psychological comic creation: Regularly carry out psychological four-panel comic competitions every year, encourage students to express their inner world through artistic forms, exhibit excellent works, and build a mental health education ecological environment of positive expression and sharing.
- (3) Student-specific psychological salons: Organize psychological salon activities that meet students’ needs according to the characteristics of different grades, focusing on topics such as emotion management, interpersonal relationships, life education, career development, and positive learning, guiding students to think in depth through case analysis and activity experience, and improving their independent psychological development capabilities.
- (4) Immersive psychological drama: Psychological drama is a unique, action-oriented group psychological healing method and a professional healing process. Through immersive experience, students can deepen and reshape cognition, stimulate empathy, acquire skills for self-regulation and improvement, and vent and heal themselves.

4. Practical value and future outlook of the “Four-Line Mental Health Education” model

The construction and practice of the “Four-Line Mental Health Education” model is not only the optimization and integration of existing secondary vocational mental health education models but also an in-depth exploration at the conceptual and operational levels.

4.1. Practical value

4.1.1. Systematicness and connectivity

The greatest value of this model lies in breaking the barrier of “parallel operation” in previous mental health education work, organically connecting the four lines of early warning, mutual assistance, curriculum, and activities, forming an interconnected system of “foundation-path-support-strategy,” and realizing a systematic effect of $1 + 1 + 1 + 1 > 4$.

4.1.2. Dynamicness and closed-loop nature

The design of the early warning and intervention network shifts from static census to dynamic monitoring, establishing a closed-loop of “screening-assessment-intervention-tracking,” which greatly improves the timeliness and accuracy of psychological crisis prevention and intervention.

4.1.3. Collaboration and comprehensiveness

This model incorporates students, teachers, parents, and society into the mental health education system, and integrates social professional resources through the school-family-hospital linkage mechanism, reflecting the advanced concept of collaborative education and building a more comprehensive psychological support network.

4.1.4. Developmentalness and preventiveness

This study not only focuses on “intervention and support” for problems but also focuses on the “prevention and development” of positive qualities, promoting students’ potential development and personality improvement.

4.2. Future outlook

The in-depth research on the theoretical framework of the “Four-Line Mental Health Education” model can be carried out from the following two aspects in the future.

4.2.1. Combination of quantitative and qualitative research

Future research can design more rigorous experimental schemes to quantitatively evaluate the specific impact of this model on students’ psychological qualities (such as psychological resilience, self-efficacy, and sense of happiness). At the same time, combined with qualitative methods such as in-depth interviews and case studies, it deeply explores the psychological mechanism of the model’s role.

4.2.2. Digital and intelligent empowerment

Explore how to use big data, artificial intelligence, and other technologies to optimize dynamic psychological monitoring and improve the accuracy of early warning; develop more intelligent peer support platforms and online courses to achieve personalized push and precise services.

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Analysis of Factors Affecting the Academic Performance of College Students from Economically Disadvantaged Families and Pathways for Improvement: A Case Study of a Higher Vocational College in Sichuan

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Abstract: Assisting financially disadvantaged college students in successfully completing their studies and achieving personal growth constitutes the primary objective of educational support policies. To gain deeper insights into this cohort's academic circumstances and formulate appropriate support measures, this study employs questionnaire surveys and SPSS data processing. Using 61 financially disadvantaged students from the Automotive Inspection and Maintenance Technology programme at a higher vocational college in Sichuan as a case study, it analyses the impact of four factors on their academic performance: learning investment, psychological capital, financial pressure, and institutional support. Finally, based on these influencing factors, corresponding improvement pathways are proposed in three aspects: financial aid policies, academic support, and psychological assistance, thereby better helping financially disadvantaged students enhance their academic performance.

Keywords: Financially disadvantaged students; Academic influencing factors; Improvement pathways

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1. Research background

Economically disadvantaged college students constitute a distinct and substantial cohort within China's higher education system. Their ability to complete studies successfully, contribute to families and society post-graduation, and achieve high-quality development represents a critical national priority in social welfare. This is also pivotal to realizing educational equity and human resource development. With college expansion and the widespread implementation of financial aid policies, an increasing number of economically disadvantaged students are entering higher education. However, their academic performance remains constrained by multiple factors. Therefore, investigating these factors is crucial for enhancing educational outcomes.

2. Research questions

This study aims to examine the following questions:

- (1) Do the four factors of learning engagement, psychological capital, financial pressure, and institutional support influence college students' academic performance?
- (2) Do these factors exhibit any mediating or moderating effects?

3. Research method

This study employs a quantitative cross-sectional questionnaire survey methodology.

3.1. Research participants

The subjects comprised 61 second-year students specializing in Automotive Inspection and Maintenance Technology at Urban Vocational College of Sichuan, all officially recognized by the institution as facing financial hardship. Most hailed from rural or low-income backgrounds with relatively weak economic foundations. Consequently, all 61 eligible students were included to ensure the sample authentically reflected this specific demographic.

3.2. Research tools

The study employed a self-designed questionnaire comprising four sections: student demographics, household economic hardship and perceived stress, academic performance, and open-ended questions. The third section was further divided into four subsections: objective academic performance, learning engagement, psychological capital and social adaptation, and perceived institutional support systems. The learning engagement subsection utilized the Utrecht Work Engagement Scale-Student (UWE-S), which employs a five-point Likert scale to measure students' learning motivation and psychological investment. Following questionnaire collection, data processing and analysis were conducted using SPSS 27.0, encompassing descriptive statistics, reliability and validity testing, correlation analysis, and regression analysis.

3.3. Data collection

Questionnaires were distributed and collected via Wenjuanxing, yielding 61 valid responses. Prior consent was obtained from all participants, and questionnaire data underwent anonymisation to safeguard privacy. All data were exclusively utilized for this academic research.

4. Data analysis

4.1. Analysis of sample characteristics

Descriptive statistical analysis of the sample's basic information was conducted using SPSS. The sample characteristics are presented in Figure 1: males constituted 90.2%, aligning closely with the traditional gender selection bias in automotive inspection and maintenance technology programmes; over eighty percent of students originated from rural areas (83.6%); non-only children accounted for 80.3%; 100% of the sample had been officially recognised as "students from economically disadvantaged families," ensuring the accuracy of the sample; Household income was heavily reliant on unstable migrant labour (52.5%) and farming (29.5%), which together constituted over 80% of sources. This fragile economic model directly impacted the level of family